SASKATCHEWAN
RESEARCH
COUNCIL

FARM ENERGY MANAGEMENT PROGRAM
YEAR 3 BACKGROUND REPORT
VOLUME I

by

E. Coxworth, M. Gimby, A. Rutherford,
N.E. Jensen, H. Boerma, R. Bens and W. Gamble

SRC Technical Report No. 158

Publication R-711-3-B-84

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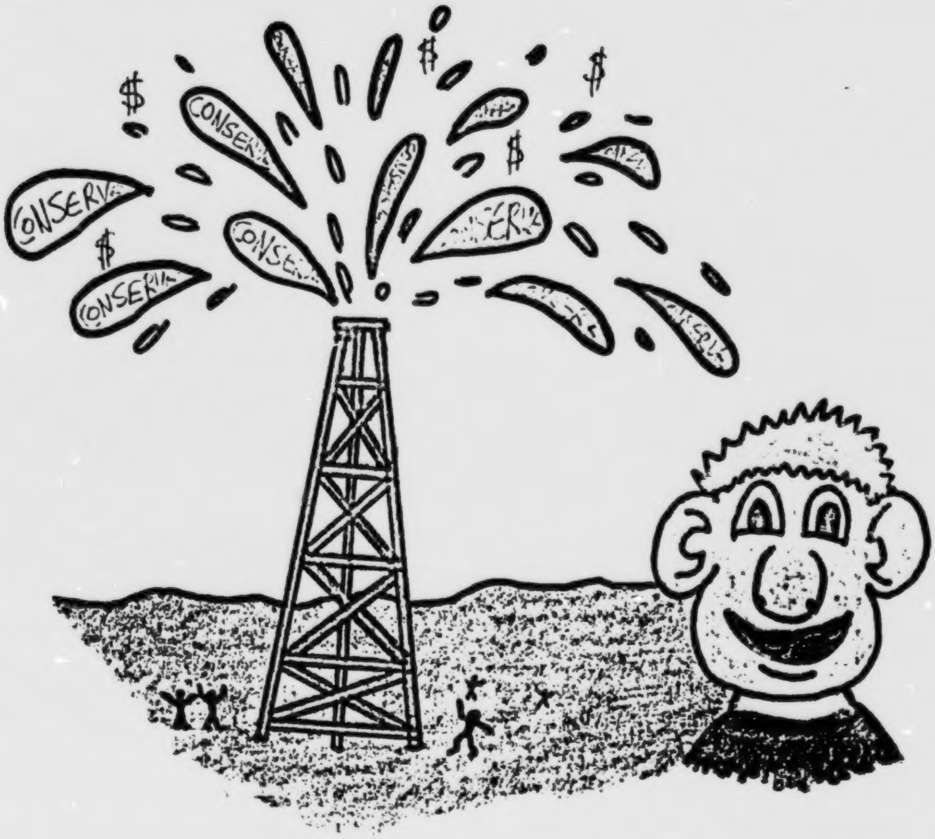
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We've struck conservation!

ACKNOWLEDGEMENTS

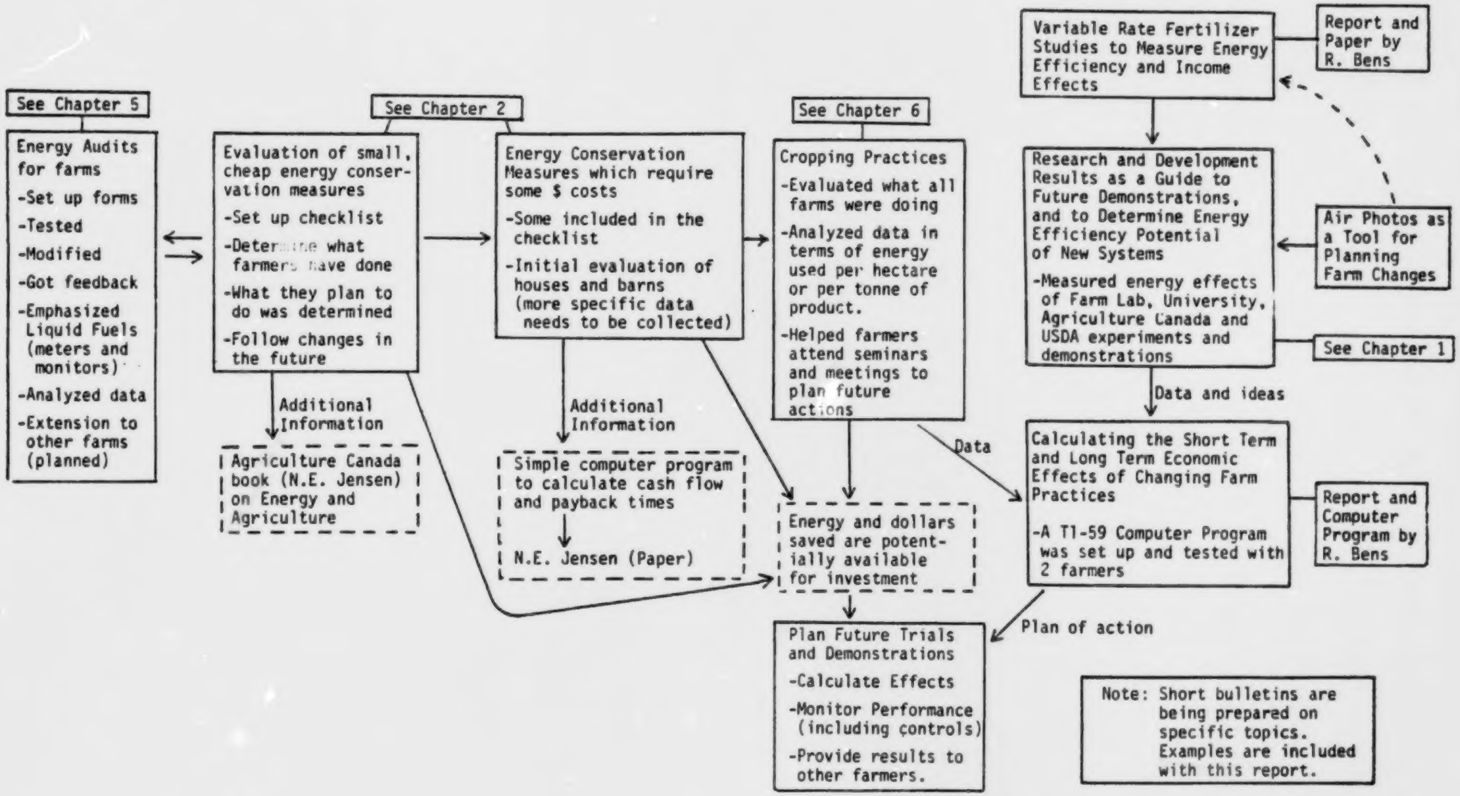
We gratefully acknowledge financing of this project by the joint Saskatchewan-Canada agreement on demonstration of energy conservation and renewable energy technologies. In particular the following individuals in two provincial government departments have participated in many meetings and helpful conversations about the project:

Martin Wrubleski, Sask. Agriculture
Paul Gebhardt, Sask. Agriculture
Jack Peck, Sask. Agriculture
Dan McFadyen, Mineral Resources
Floyd Wist, Mineral Resources

Members of the advisory committee participated in general discussions, and gave useful comments on material which is now incorporated in the introduction section:

G. Zoerb, Agriculture Eng. Dept., University of Sask.
W. Brown, Agriculture Economics Dept., University of Sask.
W. Nickolaichuk, Agriculture Canada, Research Station, Swift Current.

We particularly thank the more than 22 farm families involved for hospitality and cooperation on the several visits which we made to each of these farms.


See Chapter 5
Energy Audits for farms
-Set up forms
-Tested
-Modified
-Got feedback
-Emphasized Liquid Fuels (meters and monitors)
-Analyzed data
-Extension to other farms (planned)
See Chapter 2
Evaluation of small, cheap energy conservation measures
-Set up checklist
-Determine what farmers have done
-What they plan to do was determined
-Follow changes in the future
Additional Information
Agriculture Canada book (N.E. Jensen) on Energy and Agriculture
Energy Conservation Measures which require some $ costs
-Some included in the checklist
-Initial evaluation of houses and barns (more specific data needs to be collected)
Additional Information
Simple computer program to calculate cash flow and payback times
N.E. Jensen (Paper)
See Chapter 6
Cropping Practices
-Evaluated what all farms were doing
-Analyzed data in terms of energy used per hectare or per tonne of product.
-Helped farmers attend seminars and meetings to plan future actions
Data
Energy and dollars saved are potentially available for investment
Plan Future Trials and Demonstrations
-Calculate Effects
-Monitor Performance (including controls)
-Provide results to other farmers.
Variable Rate Fertilizer Studies to Measure Energy Efficiency and Income Effects
Report and Paper by R. Bens
Research and Development Results as a Guide to Future Demonstrations, and to Determine Energy Efficiency Potential of New Systems
-Measured energy effects of Farm Lab, University, Agriculture Canada and USDA experiments and demonstrations
Air Photos as a Tool for Planning Farm Changes
See Chapter 1
Data and ideas
Calculating the Short Term and Long Term Economic Effects of Changing Farm Practices
-A TI-59 Computer Program was set up and tested with 2 farmers
Report and Computer Program by R. Bens
Plan of action
Note: Short bulletins are being prepared on specific topics. Examples are included with this report.

Overview of the Farm Energy Management Program and a Guide to Results of This Study.

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INTRODUCTION

OVERVIEW ON ENERGY SAVINGS AND ENERGY EFFICIENCY IMPROVEMENTS ON THE FARM.

MAJOR OBJECTIVES OF THE FARM ENERGY MANAGEMENT PROGRAM.

Energy conservation has become an important factor in attempts to maintain economic prosperity as energy prices rise. Some recent examples are the following:

- Japan has had 7 years of essentially zero energy growth, yet has maintained an average economic growth rate (GDP) of 4% per year.

- In the European Economic Community during 1973-1978, it was estimated that 95% of new energy to achieve economic growth was obtained via energy conservation and only 5% via new energy supplies.

- The Saskatchewan Power Corporation (SPC) estimated that the average household used 16% less natural gas in 1980 (adjusted for a mild winter) than the yearly average in the period 1970-1975. Internally SPC has cut gas usage by 30%.

- Saskatchewan agricultural demand for direct energy (primarily liquid fuels) has decreased every year since 1976. There was a 12% reduction between 1976 and 1979 (Moroz, 1982)*.

- A recent Ontario agriculture energy study concluded that this conservation trend can continue. The study predicted that a 35% reduction was possible in tractor fuel and fertilizer energy needs for unit of crop production by the year 2000. An estimated 50% reduction in transportation energy costs was also considered possible.

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*A second estimate (Gayton, 1982, Office of Energy Conservation, Dept. of Mineral Resources) indicates a slow rise in liquid fuel use from 1971 to 1979, followed by an 8% decrease to 1981.

The Saskatchewan farm energy management program was part of this world wide trend. It aimed at finding and demonstrating short term energy conservation possibilities, and encouraging the long term trend to improved efficiency of use of energy for food production. Hopefully, the program was of value in finding methods to reduce the cost-price squeeze that many farmers find themselves in at the present time.

The overall objectives and results of the farm energy management program were:

1. To measure the energy use at the present time on 21-22 cooperating farms in terms of:
    a) where energy is used and in what amount: e.g., gasoline, diesel fuel, heating oil, electricity, fertilizer*.
    b) the time of the year when various forms of fuel are used, e.g., when are the peaks in diesel fuel use?
    c) with liquid fuels, to further subdivide fuel use down to specific unit operations: e.g., discing, harrowing, baling hay, grinding feed grains, hauling grain, etc., in order to identify the relative magnitude of different fuel uses as an aid to considering the importance of various conservation measures.

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*Indirect energy use, as in nitrogen fertilizers, has been identified as an important factor in other studies. Nitrogen fertilizer (made from natural gas) can become the major energy cost in intensive farming. Chemicals (principally herbicides) are an important dollar cost, but their energy impact is low, i.e., their use is not usually an important energy item.

2. To aid in measuring energy use, and in testing the effectiveness (cost, dollars and energy saved, payback times) of various conservation techniques, the following actions were taken:

a) provide suitable record keeping books for each liquid fuel end use (each truck, car, tractor)

b) install fuel meters on all farm fuel storage tanks, including slip tanks used for field re-fueling.

c) test, evaluate and then install fuel monitors* on major gasoline using equipment on each farm: private cars, half ton trucks, and on some field equipment (e.g., tractors, combines) to:

   i) provide a check on record keeping books

   ii) test the effectiveness of instant feedback monitors in reducing fuel consumption.

   iii) test the cost effectiveness of such on board monitors

   iv) provide more accurate fuel consumption data than from the the record books based on the "filling the tank" approach.

d) for diesel equipment (mainly large tractors and big trucks) monitors were more costly and needed more testing. Several types were considered. One type was purchased and evaluated by the Crop Science and Plant Ecology Department, University of Saskatchewan. Based on the results, three more were purchased and installed on tractors on three farms. Farmers used them to evaluate the fuel consumption of different types of field operations, and also tested various modifications to standard operations. This included testing various energy-saving options (e.g., gear up throttle down).

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*These fuel monitors gave problems in use and were not employed extensively.

e) electrical meters were planned to be installed to distinguish between various electrical energy types: e.g., hog barns (fans, heaters, and lights), home, machine shop, farmstead, irrigation pumps. Due to a variety of problems, this has yet to be done.

3. test and implement the effectiveness of various energy (and dollar saving) options we needed to:

a) know approximate present use

b) estimate the cost of conservation techniques, e.g., house retrofit, fuel monitors, equipment replacement, cost of minor options (e.g., tuning up motors, cleaning filters, keeping tires at the correct pressure).

c) identify the conservation options with the best pay back times.

d) identify what other people have done (e.g., house space heat conservation studies, cropping practices energy savings).

4. Another important category in the study was the testing of techniques which increased yields of crops relative to investment in fuel and fertilizer. Examples would include methods of fertilizer placement (e.g., deep banding), minimum tillage, use of legumes (pulse crops, forages, green manure crops) to save nitrogen fertilizer, snow management (to increase yield relative to investments in fuel and fertilizer), energy costs (e.g., nitrogen fertility losses) associated with summerfallowing.

Various results from on-farm tests and university and agriculture research station studies were used to evaluate the energy savings and/or energy efficiency improvements possible.

5. How do these crop practice savings compare with costs and savings in home and barn energy use conservation, and in the choice and use of cars, trucks, tractors, combines and other powered farm equipment?

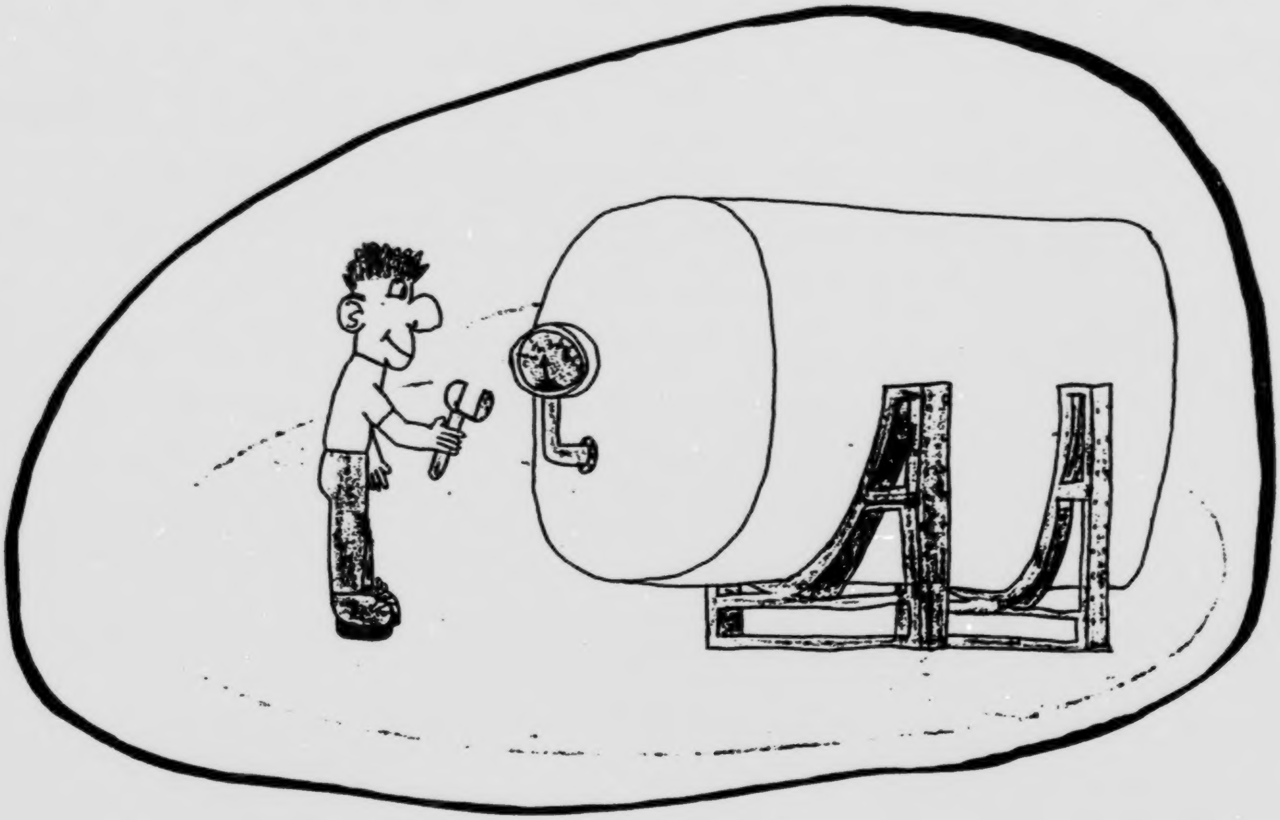
We compared conservation possibilities in the various sectors of the total farm operation (including homes and personal transportation) with the cropping practise changes which may be likely to occur in the next decade. This comparison included the effects of shifting energy use from one sector to another so as to increase food production or provide better soil protection or soil fertility enhancement.

6. Another objective was to aid the extension process of giving the results of the study to other farmers to apply to their operations.

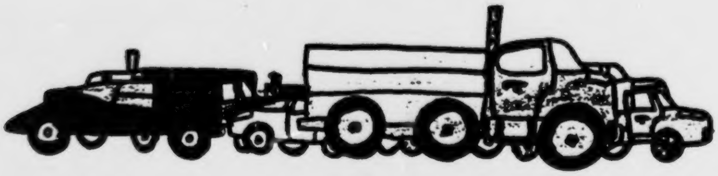
7. Finally, government policy implications might come out of the study in terms of changes or improvements which might be made. Where possible, we have enumerated such recommendations to policy and planning groups in the provincial and federal governments.

METHODS

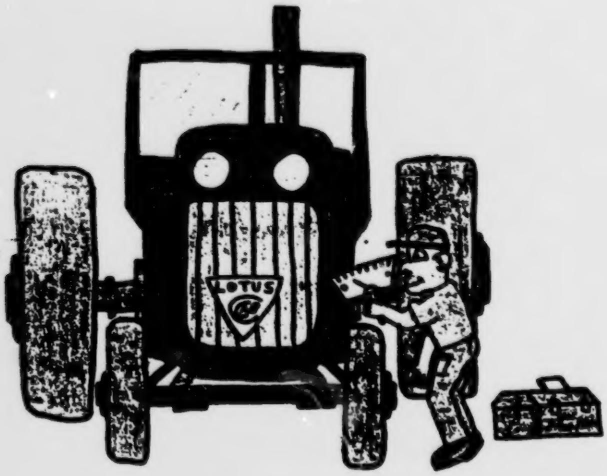
The following pictures and captions give an overview on how the data was collected, interpreted and discussed with the farmers.



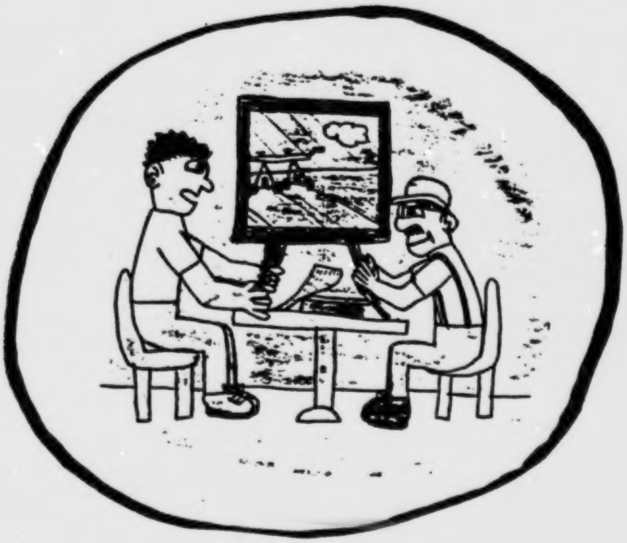
Installed fuel meters on all fuel storage tanks on the farms. Gave each farmer record books and make sure everyone knows how they are to be used.



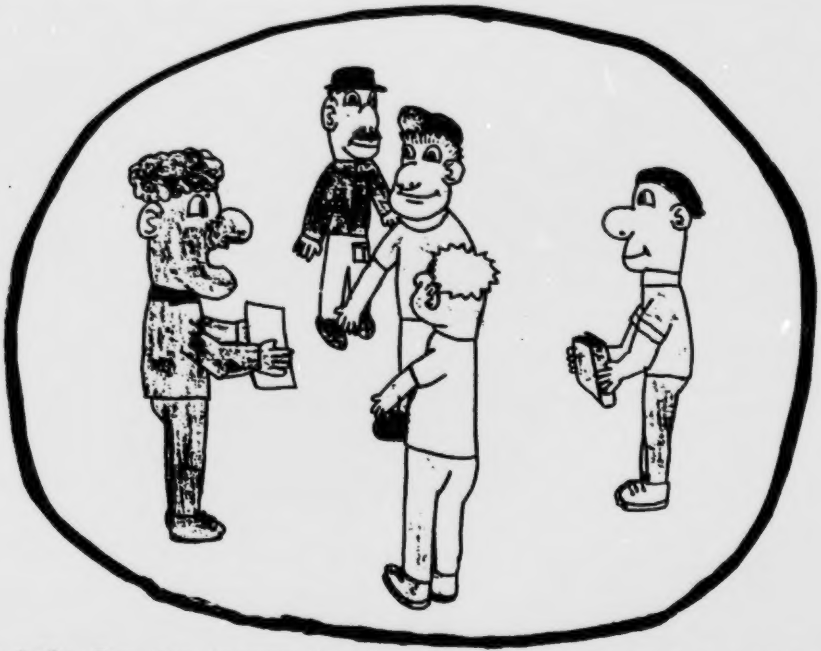
Measured all the fuel used for transportation on the farms. Find out how much is used by cars, light trucks, and heavy trucks. Determined the fuel efficiency of selected vehicles. From the average age and types of vehicles, make estimates of possible future savings possible.



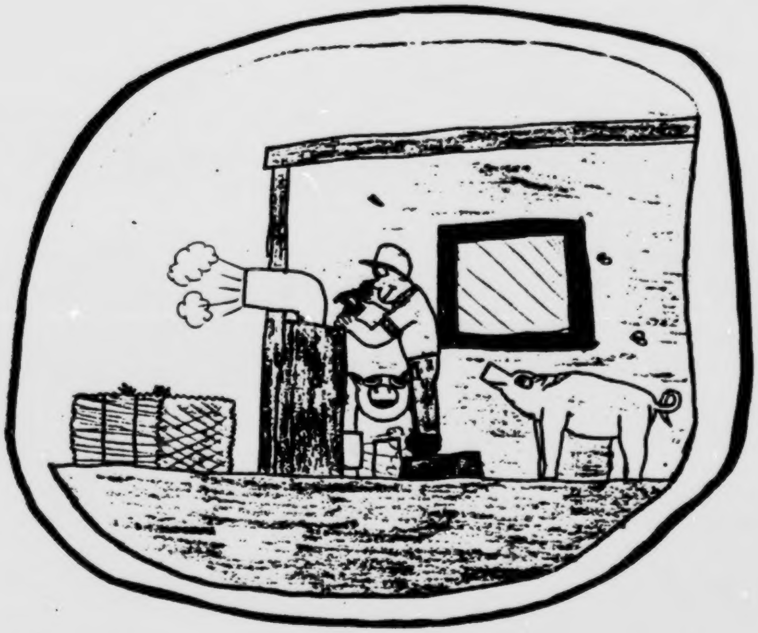
Instal on-board fuel monitors on three tractors and have farmers evaluate their usefulness.



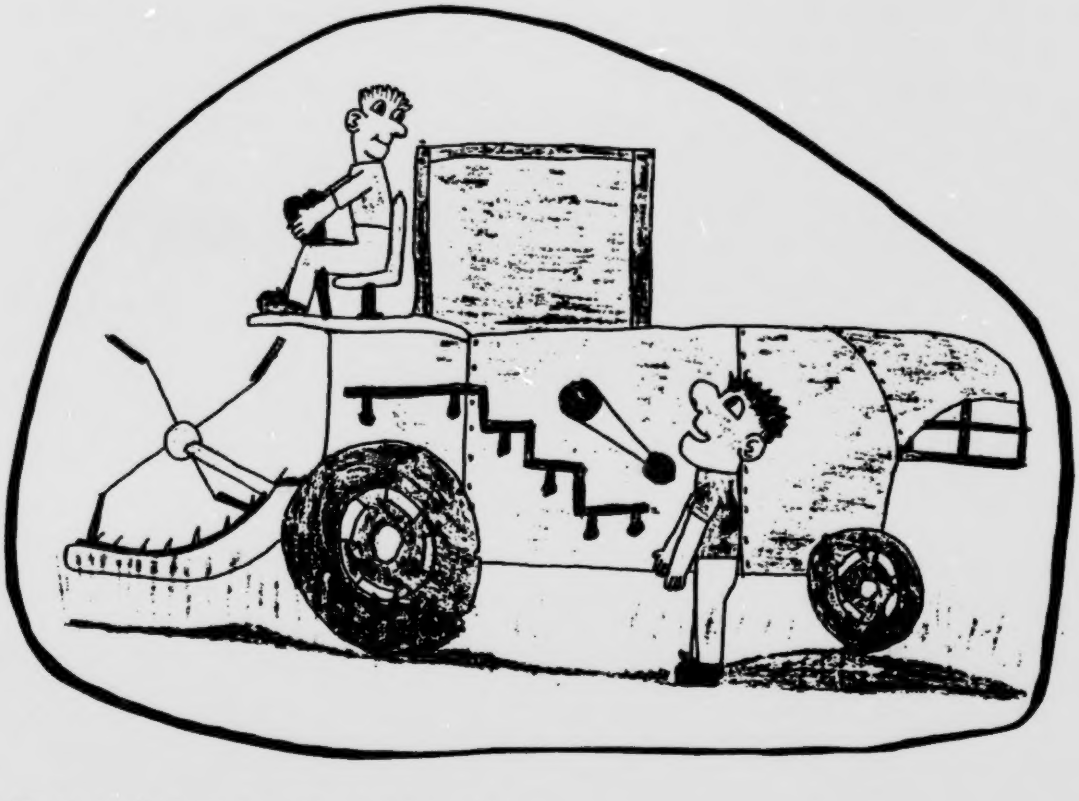
Have farmers list all the conservation actions they have taken and their plans for the future.



Arrange help for the farmer in planning for a particular conservation activity (e.g., help from agricultural scientists, engineers, and other farmers).

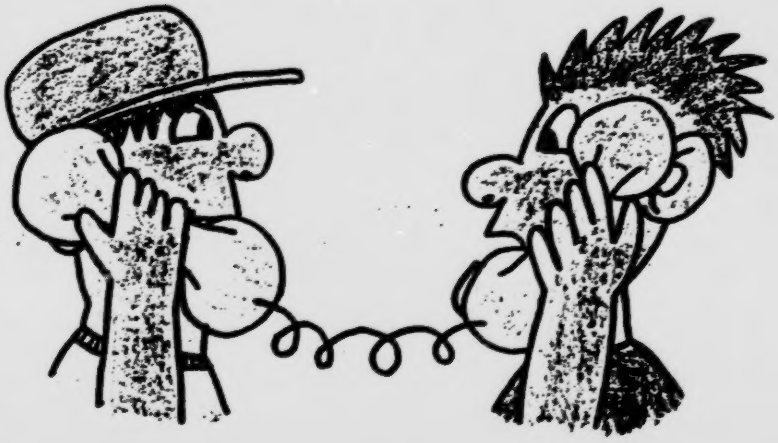


Work with each farmer in putting into place a particular conservation option. Monitor the energy savings.

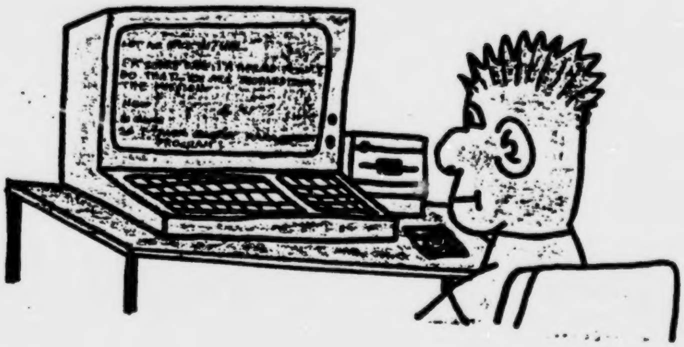


Visit each farm to get yields of crops, other information about cropping practices and results of conservation activities.

Collect record books from all the farmers and analyze the data.

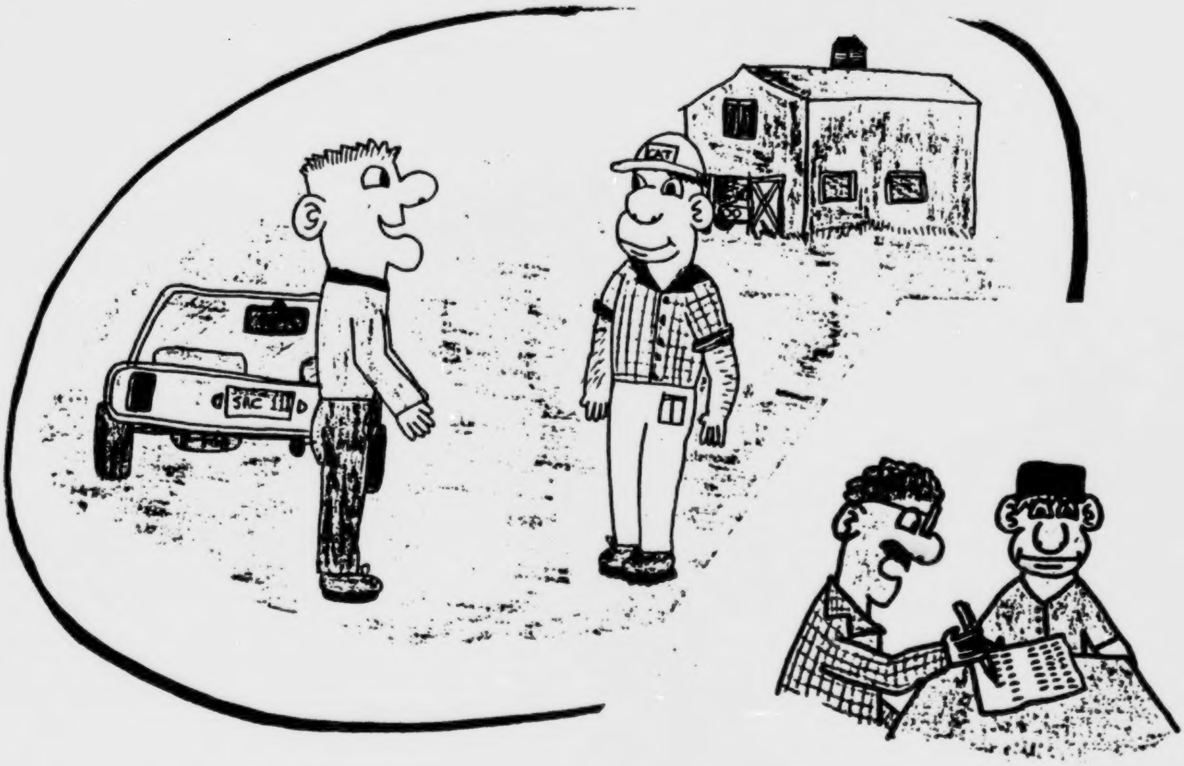


Phone or visit farmers to collect missing data and sort out other problems in interpreting the results.

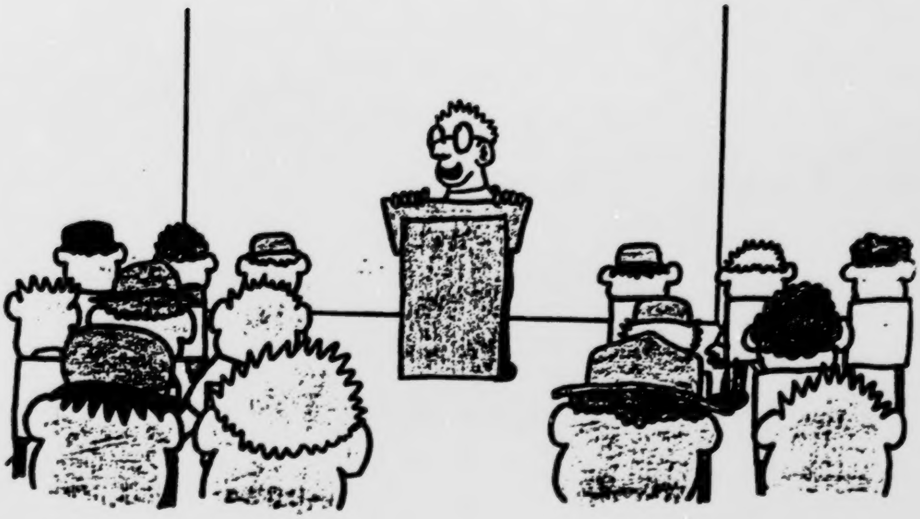


Design computer programs to analyze new cropping systems, and the cost and pay-back times of various conservation activities.

Calculate the energy implications of new cropping practises.



Visit the farmers after the results have been analyzed. Discuss the results of the energy analyses of the farm in terms of where energy is being used now, and where future conservation activities would best be directed.



Hold seminars and have farmers discuss their own experiences with various conservation actions, and plans for the future. In particular make sure there is plenty of opportunity for farmers to be able to discuss results and plans with each other.

RESULTS AND SUGGESTIONS FOR THE FUTURE

Because of the nature of the timing of obtaining results for 1983 from farmers, this is a draft interim report, since much of the 1983 data was only received and corrected in the last 6 weeks and is still being analyzed.

However a number of conclusions and ideas for future work can be made at this time, and are given below:

1. A good picture is now available on where energy is used on farms in western Canada, assuming these farms are typical. The most recent results are summarized in the Chapter 5 of this interim report. Complete results, including 1983 data, will appear in the final version.

2. Our results are most complete for overall energy use, liquid fuel use and fertilizer use. Results are least complete and accurate for home heating, barn heating, and separation of electrical use into various activities, where we had delays and set backs in getting separate meters installed.

3. A complete field by field analysis of energy used in annual crop production was done for 20 of the farms. The Saskatchewan Custom Rate tables were used to calculate fuel use, while farmers actual figures for fertilizer and herbicides were employed. Several farmers had on-board fuel monitors placed on their tractors. These monitors and the storage tank meter records were used to check the fuel use estimated from the custom rate tables. Good correspondence of fuel use data was found. The fuel use, and overall energy use (fuel, fertilizer and herbicides) was calculated for each farm, and then summarized by soil zone and type

of farming operation. The results are given in chapter 6 of this report. Fuel use tended to be lower than that reported in some earlier studies. Fuel use per hectare was highest in the black soil zone, reflecting not only more intensive cropping systems, but also more tillage operations for summerfallowing. The one farm using an intensive innovative cropping system (continuous cropping, snow management, minimum tillage, straight combining, aeration grain drying) had far higher energy related costs for fertilizer and herbicides than did other farms.

4. Fuel use for transportation (cars, light trucks, and heavy trucks) used 42% of the liquid fuels employed on the farms. Fuel efficiency of vehicles within a classification (e.g., light trucks) varied greatly. We could not see any trends in efficiency based on vehicle age although we may not have had a large enough sample to determine trends reliably.

It will be important in future studies to measure fuel efficiencies of particualr vehicles against controls, e.g., older vehicles of similar size and function, to more accurately assess changes in fuel efficiency. According to recent studies, improvements in fuel efficiency of the overall North American automobile fleet are just beginning to be seen. At the most recent seminar held on the project (March, 1984) a number of farmers expressed dissatification with smaller vehicles, diesel powered smaller vehicles, and the fuel efficiency of new vehicles in general. It will be important to follow changes in the transportation fleet of individual farms, and the changes in fuel efficiency, as older vehicles are traded in. A number of farmers were surprized and dismayed to see how much fuel was used by half-ton trucks, and were interested in reducing this type of fuel use. Since Saskatchewan has some of the lowest fuel prices in Canada, this continued interest in fuel savings is somewhat surprising as well as encouraging.

5. Gear up-throttle down studies were conducted by the Agricultural Engineering Department of the University of Saskatchewan, as a separate study. This type of fuel savings in the operation of tractors was estimated to have the potential of saving about $360. worth of fuel per average farm. This represents about 100 liters of diesel fuel which could be saved per farm. Some farmers were hesitant to run the risk of damaging tractors by improper use of this technique. Better on-board monitors, which would record fuel consumption, power output and wheel slippage, would possibly aid adoption of this technique.

6. In general, our feeling is that we now have developed adequate methods to evaluate energy use on western Canadian farms, and have designed acceptable questionnaires and analytical systems for farmers or consultants. This would allow one to conduct a complete farm audit, to design analysis systems to follow energy use year by year, and to follow progress in energy conservation and improvements in energy efficiency (e.g., energy use per tonne of grain produced).

Audit forms and analysis systems were designed to do the following:

6.1 Measure all fuel use (tractors, trucks, cars, home heating, etc.). These were used in conjunction with meters placed on fuel storage tanks.

6.2 Measure overall energy use (fuel, fertilizer, herbicides, electricity).

6.3 Conduct field by field audits of crop production systems, and calculate the energy efficiency of new or improved cropping practises compared to older systems.

6.4 Inventory many small and cheap energy conservation practises, and thus plan phasing in activities not yet implemented.

6.5 Evaluate the cost of more expensive energy conservation activities (e.g., retrofitting a house) and calculate the most effective financing methods to pay for these.

6.6 Calculate the economic cost and gain of changing cropping systems. A T1-59 programmable calculator was used to design a simple system which could be used by farmer or energy/agricultural consultant.

7. Research and demonstration studies were conducted to test a method of analyzing variations in fertility within a field and of then applying extra fertilizer only to those areas of the field (e.g., eroded knoll-tops) needing it. Air photographs were used, along with soil analysis, to plot the fertilizer needs of two particular fields. Testing of the method gave very positive results both in dollar and energy terms. From 2-7 times as much extra food energy (wheat grain) was obtained as was invested in extra fertilizer energy.

High technology methods are being developed to automatically apply fertilizer to a field after air photos (and soil analysis) have been used to plot variable fertilizer needs. A private company in Saskatoon is conducting research on developing this new technology. The reports by R. Bens should be read to gain details on this new technique.

8. Soil protection and enhancement of soil fertility are major topic's of concern in western Canadian agriculture. More intensive cropping systems, with improved use of all available moisture, greater use of fertilizers, and use of reduced tillage methods are involved in many of the research and commercial methods being developed. Results from Farm Lab demonstrations and university and agriculture research station experiments were analyzed to determine energy efficiencies. These results are given in chapter 1. Also included therein are estimates of energy conservation savings on the farm (house, cars, trucks, tractors, electricity) and calculations of how energy savings could be invested in more intensive cropping systems to produce more food, provide better soil protection, and reduce losses in soil organic matter and available nitrogen.

Investment of energy savings in more intensive cropping practices appears to offer the opportunity for very substantial increases in food production with only modest increases overall in energy consumption in the whole farm operation.

9. Farmers have been found, via questionnaires, to have made many energy conservation changes on their farms. These range from building new energy efficient homes to small, simple measures such as painting fuel tanks silver to reduce fuel evaporation losses. An example of one farm is given in chapter 2. Other specific farm examples will be given in the final report.

FUTURE RECOMMENDATIONS

1. It took us longer to learn the process of getting reliable energy measurements from farms than we anticipated. In some cases, e.g., electrical use, further work needs to be done to specify energy uses so as to separate home heating, for example, from barn electrical use. Therefore, on some farms, electrical meters need to be installed to separate different electrical uses from each other. This will complete energy audits on farms.

Some testing of the existing forms could be done with other farmers, to determine how useful the forms are, and whether farmers can do their own audits.

2. The main effort in the future should be directed towards specific energy conservation or farming practises. More farmers with innovative farming practises would be selected to get a broader base in this category. Existing Farm Lab experiments could likely be used in many instances, provided we could get the necessary energy inputs from the farmers and/or Farm Lab staff.

3. Further studies are needed to correlate custom rate fuel estimates with actual farm measured fuel use. Plans are underway to select 6 farmers who would record all unit operations, and fuel use, on a few specific fields. Use of on-board tractor fuel use monitors would facilitate this process. From this study we could arrive at good representative fuel use figures which could then be used on other farms to estimate fuel use of particular farming methods.

4. Suitable controls need to be built into demonstrations to allow a good comparison, or good before and after data to be developed.

Although this sounds obvious, we have not always found it easy to do given farmers' complex operations.

5. Some energy input numbers, e.g., for phosphate fertilizer, and for certain herbicides, needs to be updated and corrected. For example, much of the phosphate fertilizer used in western Canada is mined in Montana. Thus earlier figures derived for eastern Canada, based on Florida sources of phosphate rock cannot be used.

Chapter 1.

Overview of Energy Conservation in Agriculture, Fertilizer Use, the Drive to Increase Food Production, and Research to Obtain Better Protection of Soils.

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Chapter 1

ABSTRACT

The general trends we believe are happening in energy use in farming are as follows:

1. Reduction in home energy use, particularly for space heating.
2. Reduction in fuel use for transportation, as older, less efficient vehicles are traded in for newer, more efficient ones.
3. Increase in fertilizer use, particularly nitrogen.
4. Further research on, and application of, more efficient ways to utilize fertilizer, e.g., deep banding or nesting techniques, fertilization techniques coupled with snow management.
5. Development and utilization of crops that gave more yield per investment in fertilizer. Examples could be winter wheat or triple M wheat.
6. Development of legume use, e.g., green manures, to provide some of N fertilizer needs, and to increase organic matter content of soils.
7. Research into non-legume nitrogen fixing systems, e.g., nitrogen fixing systems, e.g., nitrogen fixing bacteria associated with wheat.

The sections of this chapter give examples illustrating items 1-6. Also included is a section on how top level skills in farming can effect the returns to energy investment of fuel, fertilizer and herbicides, based on a recent study of a large group (297) of farmers growing canola in Alberta. This could be considered an example of an eighth trend:

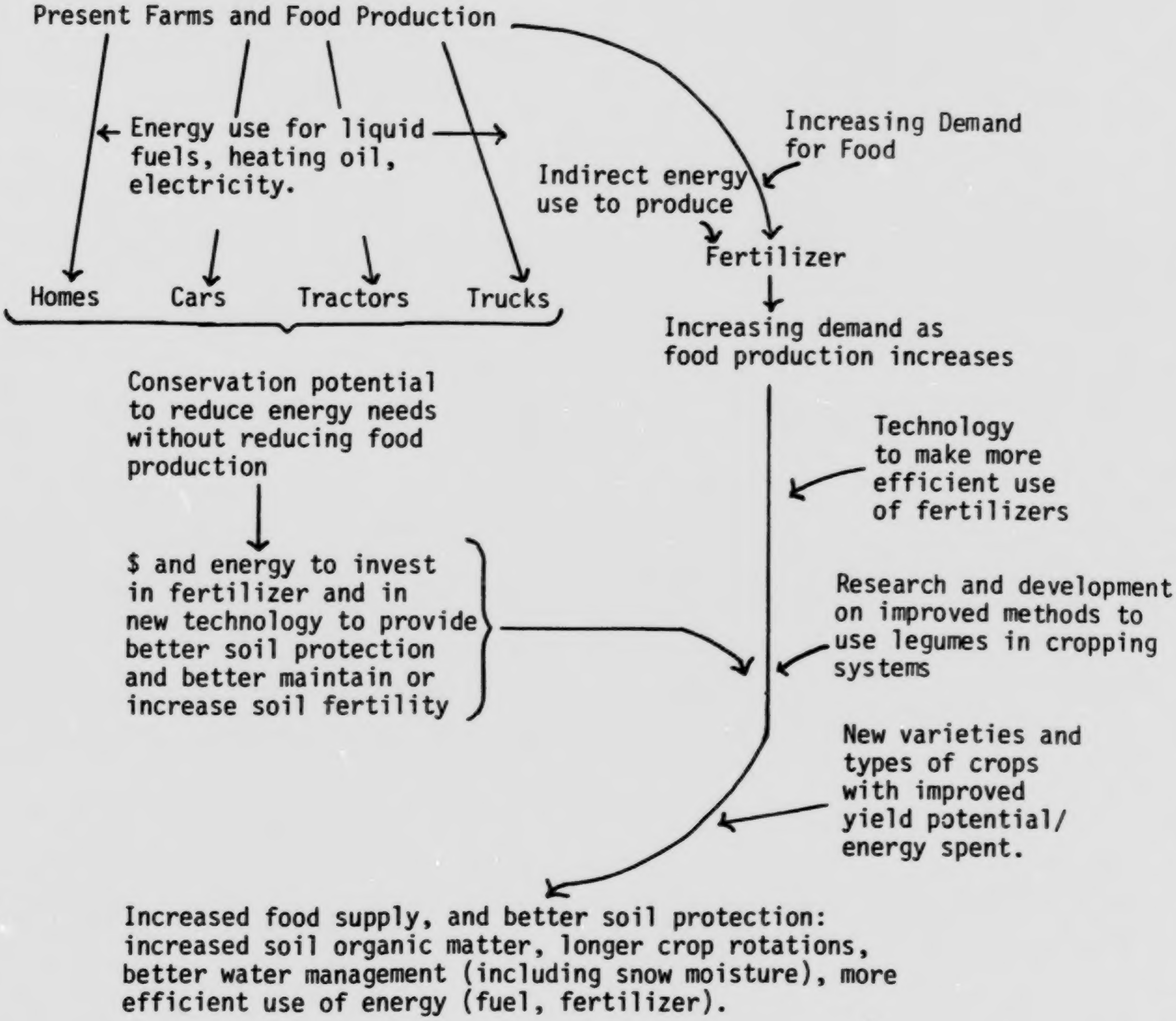
8. Improvement in the skills of farming to increase yields relative to investments.

Chapter 1

Overview of Energy Conservation in Agriculture, Fertilizer Use, the Drive to Increase Food Production, and Research to Obtain Better Protection of Soils.

1.1 Introduction

As the title of this chapter indicates, there are a number of related research and development factors operating in western Canada. However, they are all linked in a general framework which is shown below:


Present Farms and Food Production
Energy use for liquid fuels, heating oil, electricity.
Homes
Cars
Tractors
Trucks
Increasing Demand for Food
Indirect energy use to produce
Fertilizer
Increasing demand as food production increases
Conservation potential to reduce energy needs without reducing food production
$ and energy to invest in fertilizer and in new technology to provide better soil protection and better maintain or increase soil fertility
Technology to make more efficient use of fertilizers
Research and development on improved methods to use legumes in cropping systems
New varieties and types of crops with improved yield potential/ energy spent.
Increased food supply, and better soil protection: increased soil organic matter, longer crop rotations, better water management (including snow moisture), more efficient use of energy (fuel, fertilizer).

This chapter examines the energy implications of increased fertilizer use. It also looks, in a general way, at the potential for energy conservation on farms, including the use of energy in the home and for personal transportation, as well as the energy used as fuel in tractors, trucks and combines. Using data from an average Saskatchewan farm, there appear to us to be substantial opportunities to save energy. By investing the dollars and energy saved in efficient use of fertilizer, it looks as if food production can be increased markedly with only a slight increase in energy use.* By taking advantage of new developments in crop breeding (e.g. triple M wheats, winter wheat, hybrid canola) it appears possible to increase yield, per unit of energy invested, quite substantially. The possible outcome could be a large increase in food production with only a very slight overall increase in energy use. Thus we could increase the efficiency of energy for food production (food output ÷ energy input) very markedly.

The next section examines the fertilizer energy implications (substantial increase) of greater food production. The section following that looks at how this increase in fertilizer energy needs might be met, in large measure, by conservation in other parts of farm energy use, or, in other cases, by conservation in other parts of Canada's economy.

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* This is not necessarily the way a farmer would look at the situation, i.e., investing dollars, saved in fuel for house and cars, in more fertilizer to grow more crop. We find it a useful "thought experiment" to look at changes in energy flows on farms, and estimate the economic effects of these changes.

1.2 Fertilizer Use: Energy Implications

1.2.1 Overview

Fertilizer manufacture requires large amounts of energy. In the case of ammonia fertilizer, an energy source, natural gas, is also required as a raw material to make hydrogen, which is combined with nitrogen from the air to make ammonia. Thus nitrogen fertilizer, per kilogram of N, requires as much energy to make as is contained in the diesel fuel required to run farm machinery (Table 1). Table 1 also shows that phosphorous fertilizers require much less energy for their manufacture than do nitrogen fertilizers.

Nitrogen fertilizer use is rising rapidly in Saskatchewan and could soon equal or surpass liquid fuels as the largest single use of energy on Saskatchewan farms. Beaton (1980) has reviewed present fertilizer use in western Canada*, and projected possible requirements for the future. To meet a production target of 54 million tonnes of grain and oilseeds for 1990 would require about 2,482,000 tonnes of nitrogen fertilizer. This estimate was based on all the nitrogen in the grain and oilseeds to be grown, and assumed a 50% efficiency of fertilizer use. This amount compares with 591,000 tonnes used in 1979. Thus a 4.2-fold increase in nitrogen fertilizer use could be expected in a little over a decade.

This increase in nitrogen fertilizer use represents a very large investment of energy, mainly in the form of natural gas. According to recent trends, the main nitrogen fertilizer sources in the future will be anhydrous ammonia and urea (Beaton, 1980). Using an average value of 65.9 GJ/tonne N for a 50:50 use mix of these fertilizers (from Table 1),

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* Manitoba, Saskatchewan, Alberta and British Columbia

Table 1. Energy content of fuels, and energy required to manufacture fertilizers

Fuel[1]	MJ/L	MJ/kg
Diesel fuel	38.7	45.5
Gasoline	34.7	46.9

Fertilizers[2]		MJ/kg	MJ/kg N
Anhydrous Ammonia	(82-0-0)	47.3	59.1
Urea	(45-0-0)	32.7	72.7
Ammonium nitrate	(33-0-0)	23.8	72.1
Mono ammonium phosphate	(11-55-0)	14.2	
Ammonium nitrate phosphate	(23-23-0)	19.2	
Ammonium nitrate phosphate	(25-25-0)	21.5	
Ammonium nitrate phosphate	(27-27-0)	25.0	
Ammonium nitrate phosphate	(34-17-0)	26.0	

[1] Fuel values are higher heats of combustion reported by Statistics Canada (1983).

[2] Energy required to manufacture fertilizer is the actual fuel consumed (AFC) to produce the fertilizer shown. These are the AFC values calculated by Southwell and Rothwell (1978). Compound fertilizers were calculated based on AFC values for components. For comparison Smil, Nachman and Long (1983) reported on fuel consumed by modern plants to manufacture N fertilizers as follows: anhydrous ammonia = 58 MJ/kg N, urea = 69 MJ/kg N, ammonium nitrate = 60 MJ/kg N.

A complete analysis of energy use would include the energy required to mine and transport phosphate rock to the processing plant. Because of differences in mine sources and sites of processing plants in western Canada, mining and transport energy cost have not been included. If they were, energy costs for P_2O_5 would be about doubled.

we have estimated the energy investment in the increased nitrogen fertilizer use to be (2,482,000 - 591,000) tonnes x 65.9 GJ/tonne = 124 million GJ or 124 PJ (petajoules)* of energy.

How big is 124 PJ? For comparison, all natural gas used for space and water heating in Canada was 792 PJ (Bott, Brooks and Robinson, 1983). At first glance, this new use of natural gas looks like a large increase in the future consumption. However, much of the natural gas used in Canada was employed to heat very thermally inefficient buildings. One recent forecast (Bott, Brooks and Robinson, 1983) estimated that new thermally efficient homes and buildings in 2025 will use only one-tenth the low-temperature heat (i.e. for space heat and hot water) required for today's buildings. Retrofits of existing housing can frequently save at least 20% of space heating costs by such measures as sealing cracks and increasing insulation in basement walls and in attics (Wall, Goldman and Rosenfeld, 1983). We believe it is quite possible that a combination of retrofits and new thermally efficient construction could save 15-20% of present natural gas heating usage, and offset the new increase in natural gas demand for nitrogen fertilizer manufacture (c. f. Figure 1).

Thus in the future a larger fraction of natural gas use might be used for fertilizer manufacture and other chemicals and industrial materials, and a smaller fraction for heating. This is in line with low energy use forecasts for the future such as those of Bott, Brooks and Robinson (1983).

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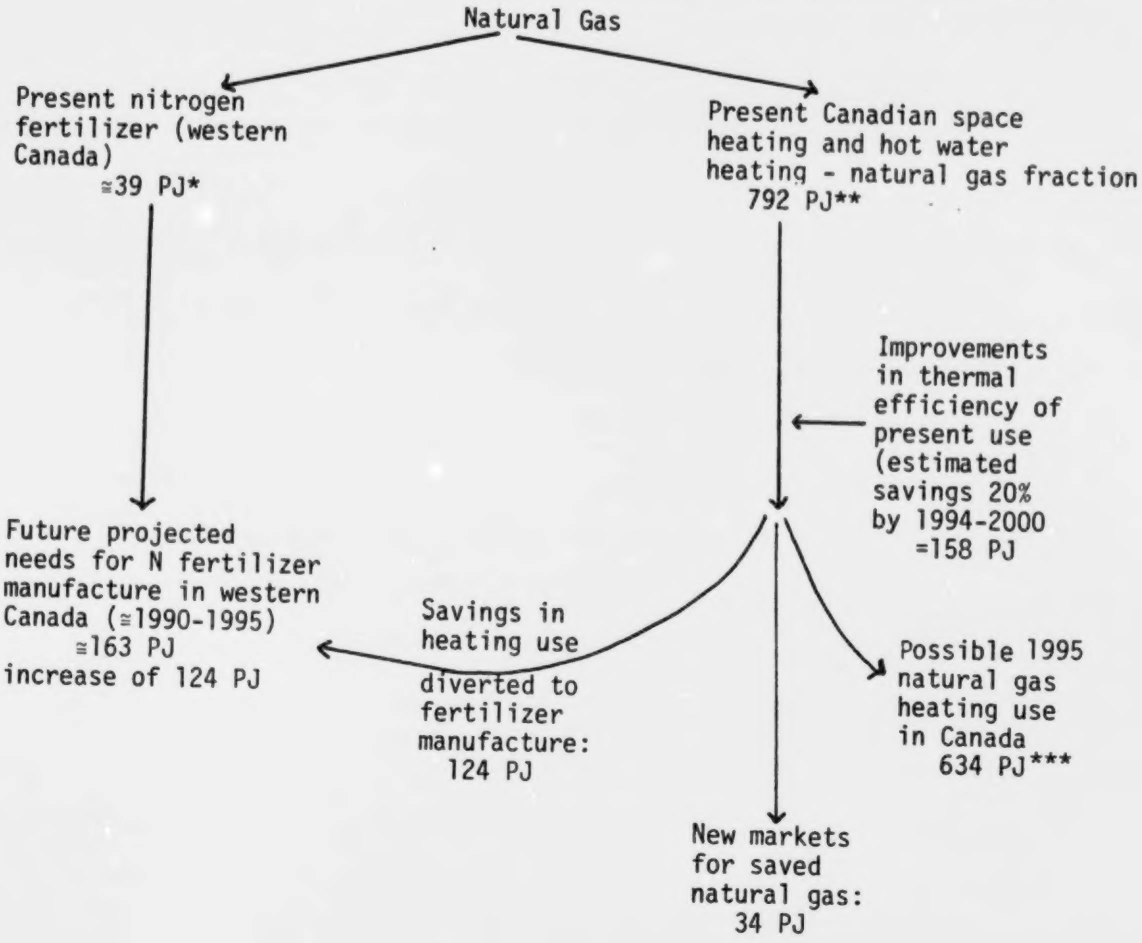
*1 PJ = 10^{15} joules (in 1979 Saskatchewan used 300 PJ in direct energy consumption - petroleum products, natural gas, coal, electricity).

Figure 1. A scenario for future shifting of some natural gas now used for space heating and hot water heating to fertilizer manufacture.


Natural Gas
Present nitrogen fertilizer (western Canada) ≅39 PJ*
Present Canadian space heating and hot water heating - natural gas fraction 792 PJ**
Improvements in thermal efficiency of present use (estimated savings 20% by 1994-2000 =158 PJ
Future projected needs for N fertilizer manufacture in western Canada (≅1990-1995) ≅163 PJ increase of 124 PJ
Savings in heating use diverted to fertilizer manufacture: 124 PJ
Possible 1995 natural gas heating use in Canada 634 PJ***
New markets for saved natural gas: 34 PJ

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* According to Southwell and Rothwell (1978), 97% of the energy to produce ammonia is derived from natural gas; the corresponding figure for urea is 92%.

** For comparison, estimates of Canada's natural gas proven reserves are given as 95,000 PJ, and potential reserves as 369,000 PJ, not including the Deep Basin reserves in northern B.C.-Alberta (Star Phoenix, 1983). Another estimate gave known reserves as 132,000 PJ and potential reserves as 3-4 times that (Sorensen and Thordarson, 1984).

*** Some estimates of natural gas use for space heating in 1990 and beyond (see Sorensen and Thordarson, 1984) assume an increase, partly because natural gas replaces some presently used fuel oil.

1.2.2. Saskatchewan

What would a 4.2-fold increase in nitrogen fertilizer use mean to Saskatchewan? According to Gayton (1982) Saskatchewan farmers used about 7 PJ of energy as nitrogen fertilizer in 1979. According to Beaton (1980) Saskatchewan used about 145,000 tonnes of nitrogen fertilizer in 1979. Based on an average energy content of 65.9 GJ/tonne of N (equivalent to a 50:50 use mix of urea and anhydrous ammonia) this would represent an energy investment of 9.5 PJ, somewhat more than Gayton's estimate. A 4.2 times increase, as estimated by Beaton (1980) would mean the use of 609,000 tonnes in 1990. In energy terms this is equivalent to 40 PJ. This is slightly more energy than was used as liquid farm fuels (gasoline and diesel) in 1979, when total farm fuel use amounted to 34.5 PJ (Gayton, 1982).

Rennie (1978) has reviewed the rate of loss of soil nitrogen since western Canada was settled. About 42 kg nitrogen per hectare per year has been released as readily available nitrogen from soil organic matter, with about 14 kg nitrogen sold off the farm (as the protein in the wheat, for example), the rest being lost to leaching, denitrification, and erosion. To replace this nitrogen on all the 16.2 million cultivated hectares in Saskatchewan would require 680,000 tonnes per year of nitrogen as fertilizer, roughly the same as the amount calculated by Beaton (1980) to meet Saskatchewan's portion of the 1990 increased food production goal of 54 million tonnes of grain and oilseeds.[*]

At the Prairie Production Symposium held in Saskatoon on October 29-31, 1980, it was concluded that to achieve a 50% increase in grain production between 1980-1990, farmers in the Prairie Provinces would have to do the following:

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[*] A more recent projection of future fertilizer use in Saskatchewan estimated nitrogen fertilizer use of about 450,000 tonnes by 2000 (Hamm and Cameron, 1983).

1. Reduce fallow significantly,
2. Practice better snow conservation,
3. Use more fertilizer,
4. Make more efficient use of fertilizers,
5. Use more extended rotations,
6. Move to more minimum tillage.
7. Related to these actions is the objective of attempting to find ways to make more use of legumes to provide some of the increased nitrogen fertilizer needs.

The following sections of this chapter look at:

- potential for energy savings on a typical farm and how these might be invested in fertilizer for more food production
- recent changes in fertilizer use
- the effects on energy use which might occur with changes in the crops grown
- methods being used to improve the efficiency of use of fertilizers
- new studies on the use of legumes
- energy and dollar implications of these developments

Prices for agricultural products, fuel and fertilizer used for the following examples were based on recent quotations from elevator operators, and farm dealers of fuel and fertilizer. Grain prices are considerably less than those for the fall of 1983 (see Year 2 report) and reflect recent depressed markets. The relatively high prices for oilseeds reflect the major price increase which has occurred since the summer of 1983.

Prices for grains and oilseeds are shown in Table 3, and prices for fuels and fertilizer in Table 2.

Table 2. Prices of fuels and fertilizers for spring, 1983, Saskatoon, Saskatchewan.

Fertilizers	Price ($) Per tonne of fertilizer	Price ($) Per kg of N
82-0-0 (anhydrous ammonia)	380	0.46
46-0-0 (urea)	276	0.60
34-0-0 (ammonium nitrate)	193	0.57
11-51-0	349	
23-23-0	278	
26-13-0	256	
27-27-0	344	
34-17-0	337	
16-20-0	280	

Source: Fertilizer bulk dealer, Saskatoon, 19 December 1983 (quoted prices were those for May, 1983)

Fuel	¢ per litre	$ per GJ
Diesel fuel	36.6	9.46
Gasoline	38.3	11.04

Source: Fuel bulk dealer, Saskatoon, 19 December 1983

Fuel oil	34.7	8.97
Electricity	4.25¢/KWhr.	11.81

Sources: Fuel oil: Several fuel oil dealers, Saskatoon; Electricity: Saskatchewan Power Corporation

Table 3. Prices for cereal grains and oilseeds including estimates of final payments (1983-84 crop year, i.e. 1983 harvested crop)

Commodity	Initial payment $/tonne	Estimated final payment $/tonne	Final total price $/tonne
Wheat			
#1 CW >13.5% protein	159.98	10.14	170.12
#1 CW	157.77	10.00	167.77
#2 CW	151.98	9.63	161.61
Average #1 and #2	154.88	9.82	164.70
Barley			
#1 Feed	96.30	40.88	137.18
Durham Wheat			
#1 CW	152.70	25.00	177.70
Oats			
#1 feed	84.50	45.39	129.89
Rye			
#1 Canadian			104.15
Canola			
#1 Canadian			341.98
Flaxseed			
#1 Canadian			311.32
Mustard			308.70

Initial prices were obtained from Pioneer Grain, Saskatoon, December 19, 1983. Final payment estimates were obtained from V. Scheidt, Marketing and Economics Branch, Saskatchewan Agriculture, Regina, Saskatchewan on January 6, 1984.

1.3 Potential for Changes in Energy Use and Income, on an Average Saskatchewan farm, Which Might be Achieved by Conservation in Home, Car and Tractor Use, and Hypothetically Invested in Fertilizer to Grow More Crop.

The home and personal transport on a typical Saskatchewan grain farm uses a surprisingly large fraction of the total energy. We used statistics to define such a farm and estimated the energy which might be saved in fuel and electricity costs in the home, and in cars and half-ton trucks by trading in for more efficient ones. We also added potential savings in tractor fuel use. We then tested the potential for investing this saved energy (and dollars) in efficient use of fertilizer to grow more crop. That is, we simulated investing the energy savings in the production of more food energy for sale. This is a "thought experiment" to test the possible consequences of shifting the energy flow on a typical farm.

Don Gayton (1983) has investigated the energy use on a typical Saskatchewan grain farm[*] in 1980. The typical grain farm was simulated based on provincial statistics and represents an 'average' farm derived therefrom. Energy consumption was distributed as follows:

Farm size: 281 hectares (694 acres) (cultivated land only)

Field crop operations:

- Liquid fuel (as diesel fuel): 31.2 L/ha, i.e. 8767L or 1.21 GJ/ha or, for all cultivated land, 464 GJ
- Nitrogen fertilizer: 0.38 GJ/ha. This is equivalent to 10.5 kg N/ha (about 10 lbs/acre) on half the cultivated land in crop. Total for all cultivated land is 107 GJ.

. Home heating	250 GJ
. Home appliance use	26 GJ
. Home hot water	22 GJ
. Personal transport	130 GJ

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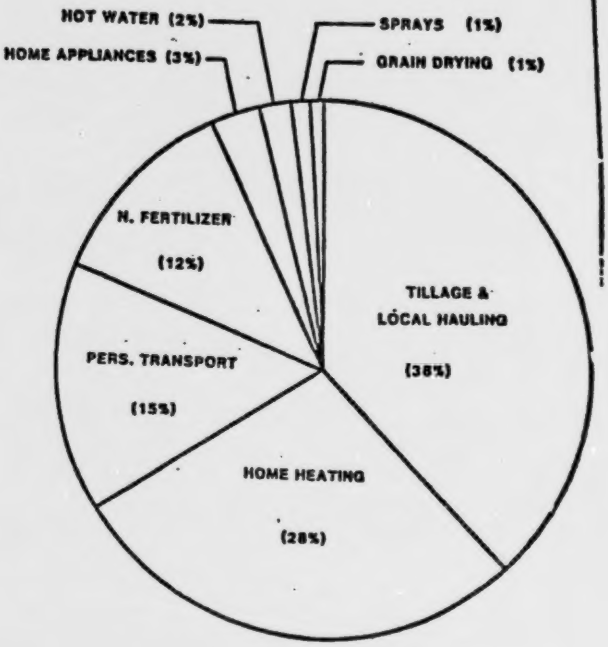
[*] The typical Saskatchewan farm was derived from provincial statistics so as to give the size and energy uses shown.

Figure 2. End-Use Breakdown, Average farm growing annual field crops (1980) (Gayton, 1983)



The distribution is shown on the accompanying chart (Figure 2), taken from Gayton's paper. Personal use (home heating, personal transport, hot water, home appliances) take almost as much energy (48%) as does crop production (52%). Is it possible to reduce energy use by conservation in some areas so this energy can be invested in more intensive and greater food production?

As an example we show, with the model farm, possible scenarios to do this. Table 4 shows possible energy savings. We assumed that the energy savings are paid for out of the cost savings over a 5-year period, and then looked at the energy and dollar savings available for investment elsewhere, per year, 5 years in the future (1989). For home heating we assumed a major retrofit of the house to save about one-half of the space heating energy (Bott, Brooks and Robinson, 1983, page 49).

The savings in the transport sector assumed replacing cars and half-ton trucks of average age 1978 with a fleet of average age 1985. For cars, the average fuel efficiency is expected to improve from 14.6 litres per 100 km (19.4 mpg) in 1978 to 8.4 litres per 100 km* in 1985 (42%) (Bott, Brooks and Robinson 1983). A slightly lower figure (33%) was used since we have assumed that light trucks do not improve in efficiency as much as cars, and that farmers may buy slightly larger cars than urban residents because of country road conditions and more high-speed driving (highways, grid roads). For tractors, combines and heavy trucks we assumed an average improvement in fuel efficiency of 8%. Savings in tractor fuel of about 8% by gear up-throttle down were found recently in studies on Saskatchewan farms (Zoerb and Kushwaha, 1984). The savings are based on the fraction of total tractor hours pulling light loads for which gear up-throttle down is possible. Other energy savings, such as optimizing wheel slip of tractors, improved maintenance of tractors, could also add up to 8-10% fuel savings. For heavy trucks, a saving of 35% in fuel use per tonne-kilometre from 1978 to the year 2000 has been projected (Bott, Brooks and Robinson 1983). A more modest saving of 8% by the year 1989 (our 5 year projection date) has been assumed here. Improvements assumed in hot water heating and appliance energy efficiency are more modest than some projections (e.g. Bott, Brooks and Robinson, 1983).

We have used 1983 (December) prices as a basis for comparison.

The following table (Table 4) shows the hypothetical energy savings which might be achieved. There has been discussion within the research group as to whether the economic effects should be shown simultaneously or not. It has been decided to include them in this draft version of the final report to give a general idea of the dollar savings and how these relate to the energy savings. It is recognized that the final, more accurate and complete, analysis will require more time and calculation by agricultural economists.

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* New cars fleet averages in 1985. The scenario assumed that by 1989-1990 average fuel efficiency for all cars was the same as new cars in 1985

For example, the major retrofit of a house is a substantial cost, probably not justified (in terms of payback period) in energy savings terms alone. However, if a major retrofit was needed for other reasons, e.g. to replace siding, then the extra costs to make the retrofit as energy efficient as possible would likely be justified in terms of energy savings.

The major emphasis, in the following analyses, is on the energy savings possible, and the effects of investing this energy in energy intensive inputs (e.g. nitrogen fertilizer) to grow more food. The crude economics were added to test that the direct costs, e.g., more nitrogen fertilizer, appeared to be paid back in more dollars of food produced; i.e., that there is compatibility between energy and dollar savings and returns on energy intensive investments.

The conservation measures shown in Table 4 could save about 200 GJ of energy per year. What could happen, if this energy was invested in nitrogen fertilizer to grow more crop? This would also be investing in a new energy form (nitrogen fertilizer) to produce more food energy. Scenario 1 examines one possible outcome of such a shift in energy use on a typical Saskatchewan farm.

For a complete analysis, the After-Tax Cash Flow Program developed by N.E. Jensen (see Appendix 1) could be used.

Table 4. Possible energy savings per year on a typical Saskatchewan grain farm.

Category of energy use	Amount of energy used GJ	Projected savings %	Energy saved GJ	Cost per GJ $	Dollars saved
Home heating[5]	250.0	45	112.5	8.97[1]	1009
Home appliances	26.0	20	5.2	11.81[2]	61
Hot water heating	22.0	18	4.0	11.81[2]	47
Personal transport	130.0	33	42.9	11.04[3]	474
Tillage, harvesting and local hauling	464.0	8	37.1	9.46[4]	351
Total	892		≅202		1942

[1] fuel oil @ 34.7¢/L

[2] electricity @ 4.25¢/KWhr

[3] gasoline @ 38.3¢/L

[4] diesel fuel @ 36.6%/L

[5] This appears to us to be a rather inefficient house. We presume this represents a large old house heated with a rather inefficient oil furnace. On the farms we have studied fuel use per house was considerably less than this.

1.3.1. Scenario 1

(a) Investing Energy Savings in Area Placement of Nitrogen Fertilizer

As a first example consider the variable rate fertilizer experiments tested by Bob Bens near Biggar, Saskatchewan in 1982 and 1983 (see the bulletin on variable rate fertilizer). Extra fertilizer nitrogen was only applied to eroded knolls where soil fertility was much less than down slopes or in depressions or draws. The model farm has been assumed to have variable fertility conditions and to have 40-50% of cropped land in knolls benefiting from added N fertilizer. A two year crop-fallow system was assumed:

. Land in crop 140 hectares (346 acres)

- Cropped land to which further N fertilizer added: 56-70 hectares (138-173 acres).
- Applied urea N (60¢/kg N, energy content 72.7 MJ/kg N).
- Purchased $1,942 worth of urea = 3237 kg N.
- This is equivalent to 235 GJ, slightly more than was saved (c.f. Table 4).
- If this is applied at 50 kg N/ha (44.5 lbs N/ac), this would cover 46% of the cropped area, i.e. about what was assumed to be in eroded knolls. Based on the two year's results by Bens one might expect a return on the fertilizer investment of:

  2.75: 1 in $ of crop = $5,341

  This is a gross margin of $3,399 over the investment in fertilizer.

In energy terms the energy return (as wheat for food) would be expected (based on Bens' results) to be at least 2.25 times the fertilizer N energy investment. The investment of 235 GJ (202 GJ from savings) would return 529 GJ of food energy, i.e., 38.9 tonnes of wheat.

To put this yield increase in perspective for the whole farm, a scenario was used similar to what Bens found in 1982 and 1983 on the farm in the Biggar area (see the bulletin on variable rate fertilizer).

The overall strategy is that shown in the general framework on Page 1 (q.v.).

The overall costs and changes in their distribution are shown in Table 5.

Table 5. Distribution of costs[*] before and after conservation measures and investing savings in fertilizer

	Original Costs		New Costs	
	$	GJ	$	GJ
Home heating	2243	250.0	1233	137.5
Home appliances	307	26.0	246	20.8
Home hot water	260	22.0	213	18.0
Personal transport	1435	130.0	962	87.1
Tillage, harvesting, local hauling	4389	464.0	4038	426.9
Phosphate fertilizer (11-51-0)	2736	110.0	2736	110.0
Nitrogen fertilizer (45-0-0)	0	0.0	1942	235.0
Total	11370	1002	11370	1035.3

The following assumptions were made:

- 140 hectares (364 acres) in crop.
- Applied phosphate fertilizer 11-51-0 at the rate of 56 kg/ha (50 lbs. per acre) over all the land in crop, at the same rate. The cost of the phosphate fertilizer is $349 per tonne and the energy required to manufacture it was 14 GJ/tonne (actual fuel consumption values).
- The yield of crop in those areas not needing extra N (76 hectares) was 2141 kg/ha (40 bu/ac). The total yield was therefore 163 tonnes.

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[*] The cost analysis shown here is intended to demonstrate variable costs after the payback period is complete. It is recognized that the overall economic picture is much more complex than shown here. A more complete analysis would include machinery costs, labour, insurance, quotas. A model for calculating the economics of changing cropping systems is included in the bulletin on this topic by R. Bens.

- The area of the eroded knolls (64 hectares) would yield 1338 kg/ha (25 bu/ac) which would be increased by 608 kg/ha (9 bu/ac) by applying the extra N fertilizer. Total yield would be increased from 86 tonnes to 125 tonnes. The conversion efficiency of applied N fertilizer to grain protein was calculated to be 30% (see R. Bens, Bulletin).
- We assumed a value of wheat of $170/tonne.

The yield increases and increases in income would be as shown in the accompanying Table 6.

Table 6. Yield and income increase by investing dollars and energy saved by conservation in variable rate application of N fertilizer

	Before	After	Change
Yield (tonnes, total)	249	288	39
Income ($)	42330	48960	6630 (15.7% increase)
Variable costs for whole farm (not including herbicides) ($)	11370	11370	0
Gross margin (gross income - variable costs) ($)	30960	37590	6630 (21.4% increase)
Food energy production (GJ)	3386	3917	531
Net energy production (food energy production - energy costs of production) (GJ)	2812	3145	333
Energy used for food production only	574	772	198 (34.5% increase)
Energy used on the farm in total (including house, cars and 1/2 ton trucks) (GJ)	1002	1035	33 (3.3% increase)
Net energy production for the whole farm including house and car energy use) (GJ)	2384	2882	488 (20.9% increase)

(b) Combining the Effects of Area Placement of Fertilizer with the Effects of Higher Yielding Wheats

A further concept leading to higher yields was tested. If the model farm grew triple M wheat (e.g. HY320) the available field trials suggest there would be a yield increase of 30% over hard red spring wheat (Neepawa) (DePauw, 1984) or about 13.8% at equal use of fertilizer (estimated).

For the sake of the first example a yield increase of 13.8% was assumed although it would be expected that normally a farmer would invest in more fertilizer to gain the complete yield advantage of the triple M wheats (see the following section).

A price of $ 153/tonne was assumed for triple M (90% of hard red spring wheat). The effects are shown in Table 7.

Table 7. Yield and income effects by investing dollars and energy saved by conservation in variable rate fertilization of triple M wheat.

	Before	After	Change
Yield (tonnes)	283	327	44
Income ($)	43299	50031	6732 (15% increase)
Variable costs	11370	11370	
Net income	31929	38661	6732 (21.1% increase)
Compare with net income from Neepawa (hard red spring wheat)	30960	37590	

The combination of applying N fertilizer and switching from hard red spring wheat to triple M, gave an increase in the gross margin of $7701 (24.9%).

To reach a target of a 30% yield increase of triple M wheat over hard red spring wheat (DePauw 1984) would require investing in slightly more N fertilizer (15.3%) based on protein in the grain and total yield of grain per unit area (see Table 9, page 1.25).

If the total yield of hard red spring wheat was 288 tonnes (see Table 6) after variable rate application of N fertilizer, then one might expect a yield of triple M of 374.4 tonnes.

The energy effects are striking: before applying the conservation measures, investing in more N fertilizer, and shifting to triple M wheat, the farm produced 249 tonnes of wheat with an energy investment of 1002 GJ (including house and cars). After the shifts were made, the farm produced 374.4 tonnes of wheat, with an energy investment of 1071 GJ: only 7% more. The changes are then as shown in Table 8.

Not included in these costs and gains are various assumptions (see below) which will need to be tested, and if necessary, corrected, in a more rigorous analysis:

- There are markets for the triple M wheats.
- There are no serious new disease problems with triple M wheats as licensed.
- No more phosphate fertilizer is needed than for hard red spring wheat. Even if some further is needed it is unlikely that this would be a large cost or energy increase.
- Energy and dollar costs to harvest and haul 50% more tonnes of grain will need to be included in a more detailed analysis.
- Technology is developed to allow varying rates of fertilizer to be applied relative to field operations.
- It is worth noting that a yield of 374.4 tonnes of triple M wheat, from the farm in the final scenario, represents a total of 9120 kg N sold off the farm. The calculations of the amount of N added as urea and 11-55-0 indicates a total of 4099 kg

of N applied. This is still well short of the total removed in this summerfallow crop. The rest was removed from soil reserves. Sooner or later this will have to be replaced, by adding more fertilizer, by including legumes in the cropping system, or both. A more distant, but exciting, prospect is nitrogen fixing wheat (Rennie, 1984). The farm is 'short' a minimum of 5020 kg N, about $3010 (as urea) or in energy terms 365 GJ. If one recalls that the model farm used about 1070 GJ after all the changes were made, the deficiency of N to replace all the N in the crop represents a 34% increase in energy needs on this farm. If the estimates of the amount of new net income are about right, one could consider investing some of this in added fertilizer, or in developing cropping systems containing legumes, to reduce or eliminate depletion of soil fertility reserves.

Table 8. Changes in yield and energy by conserving energy, investing in more fertilizer and shifting from hard red spring wheat to triple M wheat.

	Before	After	Change
Yield (tonnes)	249	374.4	125.4
Energy in wheat (GJ)	3386	5092	1706
Energy to run the farm) (GJ) and for crop production)	1002	1071	69 (7% increase)
Net energy (GJ)	2384	4021	1637 (63.7% increase)
Net margin to N fertilizer costs ($)	30960	45616	14656 (47.3% increase)

(c) Possible Impact of the Introduction of Higher Yielding, Lower Protein Content Spring Wheats

There is considerable interest in several new high yielding types of wheat with lower protein content than hard red spring wheat. The "triple M" quality types (De Pauw, 1984) are designed for growing markets in Africa, Asia and South America for steamed bread, noodles, and chappaties. One reason for interest in these new wheats is that their higher yields over the common hard red spring wheats (CWRS type) might more than compensate for possible lower market prices.

What would be the effect on energy use and gross margin to M fertilizer? Recent yield and protein content results reported by DePauw (1984) at Farm and Home Week permitted some rough comparisons.

We have assumed:

. Final prices for wheat:	- per tonne
Hard red spring wheat, 14% protein	$168
"triple M" type wheat, 12% protein:	$160
or:	$151
(the assumed prices for triple M wheat are 95% and 90% that of hard red spring wheat)*	
. Costs for nitrogen fertilizer (urea)	60¢ kgN (27¢/1b)
. Food energy value of wheat grain	13.6 MJ/kg
. Energy embodied in N fertilizer	72.7 MJ/kgN
. Yields of triple M wheat and Neepawa based on comparative tests over 6 years at various sites in western Canada (see Table 9).	

In this partial comparison it has been assumed that all other $ and energy costs of production between the two wheats are the same. Not included are the relatively small extra $ and energy costs of harvesting, storing and hauling to market the higher yielding triple M crop.

The gross margin and net energy effects clearly favor the triple M wheat. We caution that this crude analysis assumes that markets are available for the triple M wheat and that there are no agronomic problems (e.g. disease).

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* It is to be stressed that the assumed prices for triple M wheat are very conjectural. Marketing trials are now commencing to attempt to define an actual market price.

Table 9. Yields, gross margin to fertilizer N, and net energy comparisons between triple M wheat (HY320) and CWRS wheat (Neepawa) (based on yield data from DePauw, 1984).

	3 M wheat (HY320)	CWRS wheat (Neepawa)
Data:		
Yield in tests (kg/ha)	3130	2408
% protein in the grain	12.3	14.0
Protein per hectare	385	337
Nitrogen per hectare (protein ÷ 5.7)	68	59
Fertilizer N requirements (@ 50% efficiency for Neepawa) kg/ha	118	118
$ effects:		
Income from wheat		
(a) assuming triple M @ $160/tonne	501	405
(b) assuming triple M @ $151/tonne	472	405
Cost of N fertilizer $/ha	71	71
Gross margin to N fertilizer:) $/ha (a)	430	334
(Wheat income - fertilizer N costs)) $/ha (b)	401	334
Energy effects:		
Food energy in wheat (GJ/ha)	42.6	32.7
N fertilizer energy expended (GJ/ha)	4.3	4.3
Net energy (partial):		
(Food energy - N fert.) (GJ/ha)	38.3	28.4

Note: the same management systems, including rate of fertilizer application, were used for both triple M and Neepawa wheats.

1.3.2. Scenario 2

Investing Energy Savings in Shifting from a Spring Wheat-Fallow Crop System to a Spring Wheat-Winter Wheat-Fallow System with Snow Management and o-till Stubble Planting of Winter Wheat.

The scenario examines the effects of investing energy savings from home, cars and other vehicles (see Table 4) in more fertilizer to grow more crops in an extended rotation (crop-crop-fallow).

There is much interest in western Canada in new and improved methods to: trap and utilize snow moisture; increase the length of the rotation; reduce tillage operations, and grow winter wheat. This type of research is the focus of many of the Farm Lab experiments (Rennie et al. 1983).

To shift from a crop-fallow system to a crop-crop-fallow system in the drier parts of the prairies requires a good moisture and snow management system and effective use of fertilizer. It would be desirable to test the system through a number of years to see how it performed in both dry years and wet years. For this purpose the results were analyzed of an experiment which has been running for 15 years in northeastern Montana (Black, Siddoway and Aase, 1983).

The system had the following characteristics:

- Compared spring wheat-fallow with spring wheat-winter wheat-fallow, both within snow trapping tall wheatgrass barrier strips.
- Used 34 kg N/ha on all crops.
- Used similar P_2O_5 on all fields (11.1 kg P_2O_5/ha).
- For this present analysis we have estimated the possible fuel and herbicide energy costs from using a o-till system for planting winter wheat, based on an analysis of actual farm results of winter wheat production in Saskatchewan (Rutherford and Fowler, 1983).

The results of the comparisons of the two systems are shown in Table 10. Winter wheat was assumed to sell for $5/tonne less than spring wheat.

Table 10. Changes in energy use and yield in shifting from a spring wheat-fallow system to a spring wheat-winter wheat-fallow system. (Based on Black, Siddoway and Aase, 1983 and winter wheat energy use from o-till results reported by Rutherford and Fowler, 1983)

	Spring wheat-fallow			Spring wheat-winter wheat-fallow		
	Yields and Inputs	Energy GJ/ha	Income and Costs $/ha	Yields and Inputs	Energy GJ/ha	Income and Costs $/ha
Yield: Yield kg/ha	2160			S.W. 2230 W.W. 1940		
kg/ha/yr of the rotation	1080	14.69	183.60	1390	18.90	233.07
Costs: Nitrogen Fertilizer						
kgN/ha/yr	17.0	1.24	10.20	22.7	1.65	13.62
Phosphorus Fertilizer						
kgP_2O_5/ha/yr	11.1	0.12	6.48	9.1	0.10	5.31
Estimated fuel use L/ha/yr	20.6	0.80	7.54	21.7	0.84	7.94
(fallow: 15.8 L/ha, S.W.:25.3 L/ha, W.W. (o-till): 24.1 L/ha)						
Herbicides (estimate)		0.11	5.76		0.15	8.10
Seed costs (67 kg/ha)		0.46	5.70		0.01	7.48
TOTAL COSTS		2.73	35.68		3.35	42.45
Net Effects: net energy and gross margin*		11.96	147.92		15.55	190.62

* Gross margin to fertilizer, fuel, herbicide and seed costs only. For a method to calculate the complete costs of changeover, see the bulletin on this topic by R. Bens.

The results shown in Table 10 can also be translated into results for the 280 hectares of cultivated land for the model farm used in Scenario 1 (see page 1.17 ff). These results are shown in Table 11.

Table 11. Whole farm (280 ha) results of switching from a two-year spring wheat-fallow system to a three-year spring wheat-winter wheat-fallow system using snow managements and o-till for winter wheat.

	Per Annum effects for:					
	Spring wheat-fallow			Spring wheat-winter wheat-fallow		
	Yields or Inputs	Energy (GJ)	Income and Costs ($)	Yields or Inputs	Energy (GJ)	Income and Costs ($)
Yield	302.4	4113	51,408	389	5292	65,260
Fertilizer						
Nitrogen	4.76	347	2,856	5.36	462	3,814
Phosphorus	3.11	34	1,814	2.55	28	1,487
Fuel Use	7280 (litres)	283	2,666	7644 (litres)	279	2,797
Herbicides		31	1,613		42	2,268
Seed Costs		129	1,596		171	2,094
TOTAL COSTS		824	10,545		1000	12,460
Net Energy (GJ)		3289			4292 (30% increase)	
Gross margin to costs of fertilizer, fuel, herbicides and seed ($)			40,863			52,800 (29% increase)

Increase in costs for 3 year system: $1915*

176 GJ*

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* If one recalls that the original savings on the typical Saskatchewan farm in home, personal transport, and tillage energy use were 202 GJ (and $1942) (see Table 4) then the "switch" from the two-year to the 3-year system, as exemplified in this experiment from Montana, could be achieved by the energy savings gained elsewhere on the farm.

Recently, a number of studies have commenced in Saskatchewan to investigate the combined effects of snow management (to trap more water for crop growth), deep banding of nitrogen fertilizer, straw and chaff management to ensure even distribution and to leave a tall stubble for snow trapping, and minimum tillage to reduce moisture loss.

The objectives of these studies are:

1. To make more efficient use of snow moisture.
2. Increase the percent of the land in crop and reduce the percent in summerfallow, so as to increase soil organic matter and soil organic nitrogen (both tending to be lost by summerfallowing).
3. Increase crop production.
4. Make efficient use of nitrogen fertilizer by techniques such as deep banding (e.g. Campbell et al., 1983).

The Farm Lab program of research and development (Rennie et al., 1983) is conducting experiments on farmer's fields throughout the province to test these principles.

The next section of this report gives an analysis of the energy effects of one such experiment carried out on the Connick farm, which is also involved in the Farm Energy Management Program.

1.3.3. Energy and Partial Economic Analysis of An Experimental Cropping System on the Connick Farm, Gull Lake (1982).

Field operations were obtained from D. Wilkinson, Farm Lab Project, Saskatchewan Institute of Pedology, University of Saskatchewan, Saskatoon, February, 1984. Costs and fuel use were obtained from Saskatchewan custom rates quotations.

The fertilizer and weed control chemicals used were as reported in the 1982 Farm Lab report (Rennie et al., 1983). For the innovative system (stubble cropping, with snow management, planting into standing stubble, with deep banding of N fertilizer) an attachment was placed on the swather which cut the 1981 crop so that a variable height stubble was left to trap snow over winter. Straw and chaff of the 1981 crop passing through the combine was spread as evenly as possible by attachments to the combine. Nitrogen fertilizer (34-0-0) was deep banded in the fall. Herbicides were applied in the fall to control weeds.

For energy and economic calculations of an extended rotation, a 3-year rotation was assumed, i.e., wheat-wheat-fallow. This also allowed comparing this system with the 3-year rotation of spring wheat-winter wheat-fallow evaluated by Black, Siddoway and Aase for 15 years in Montana.

The results are shown in Table 12.

From Table 12 it can be calculated that the innovative 3-year system used 4.558 GJ/ha/year of energy per year (3.846 GJ/ha/yr for fuel, fertilizer and herbicides), compared to 3.814 GJ/ha/yr (2.746 GJ/ha/yr for fuel, fertilizer and herbicide) for the conventional crop-fallow system.

The difference in energy related costs exclusive of seed was 1.10 GJ/ha/yr (3.846-2.746) mainly a consequence of the much larger amount of nitrogen fertilizer used for the stubble crop in the 3-year system. For a farm with a cultivated area of 281 hectares (see Scenario 1) the total increase in energy requirements for the crop production operations would be 309 GJ. The estimate of the energy savings on the model typical Saskatchewan farm (see Table 4) was 202 GJ (mainly in home, personal transport, and more efficient operation of farm vehicles). Thus about two-third's of the new energy investment needs could, in theory be provided by energy conservation savings elsewhere in the whole farm operation.

Table 12. Farm Lab Experiment: Testing an innovative stubble cropping system with snow management

Connick farm: analysis of 2-year and 3-year systems:
wt-fallow and wt-wt-fallow

Conventional Summerfallow

1. Summerfallow year	Custom rate fertilizer, seed, herbicide costs and grain income		Fuel fertilizer, seed, and herbicide costs and crop yield per hectare		
Field operations: 2 cultivars, ind. harrows:	per acre $	per hectare $	litres of fuel	GJ	$
Assumed one heavy duty cultivator followed by one field cultivator	6.00	14.83	8.11	0.314	2.97
1. chisel cultivator (chisel plow) Assumed costs of one heavy duty cultivator	2.35	5.81	4.65	0.180	1.70
2. Rod weeder operations	4.40	10.87	4.46	0.173	1.63
Total Costs	12.75	31.51	17.22	0.667	6.30

Conventional crop on fallow

2. Spring wheat planted on summerfallow	Custom rate fertilizer, seed, herbicide costs and grain income		Fuel fertilizer, seed, and herbicide costs and crop yield per hectare		
Field operations:	per acre $	per hectare $	litres of fuel	GJ	$
Discer seeder (fertilizer applied with seed)	5.00	12.36	5.07	0.196	1.86
Sprayer	1.26	3.11	1.06	0.041	0.39
Rod weeder	2.20	5.44	2.23	0.086	0.82
Swather (pulltype)	2.75	6.80	2.36	0.091	0.86
Combine (self propelled - gasoline engine)	17.75	43.86	9.11	0.316	3.49
Truck hauling (to storage bin) (10¢/bu)	3.50	8.65	3.46	0.134	1.27
Total fuel and machinery related costs	32.46	80.22	23.29	1.278	8.69
Fertilizer: 11-48-0: 40 lbs/ac (44.8 kg/ha)	6.33	15.64		0.636	15.64
Herbicide: Buctril M	5.03	12.44		0.165	12.44
Seed: 70 lbs/ac (78.5 kg/ha)	5.40	13.35		1.068	13.35
Total costs/crop year	49.22	121.65		3.147	50.12
Income: Wheat @ 35 bu/ac (2354 kg/ha)		400.18		32.016	400.18
Net energy and gross margin (to fuel, fertilizer, herbicide costs)				28.869	349.96

Table 12. (continued)

Stubble crop:
.Snow management
.plant into standing stubble
.Deep band N fertilizer

3. Stubble wheat crop (innovative system)	Custom rate fertilizer, seed, herbicide costs and grain income		Fuel fertilizer, seed, and herbicide costs and crop yield per hectare		
Field Operations:	per acre $	per hectare $	litres of fuel	GJ	$
Spiked in nitrogen fertilizer (assumed heavy duty cultivator costs)	2.35	5.81	4.65	0.180	1.70
Discer seeder (phosphate applied with seed)	5.00	12.36	5.07	0.196	1.86
Sprayer	1.26	3.11	1.06	0.041	0.39
Swather (pull type)	2.75	6.80	2.36	0.091	0.86
Combine (sp)	17.75	43.86	9.11	0.316	3.49
Truck hauling (10¢/bu)	14.40	10.87	4.35	0.168	1.59
Total fuel and machinery related costs	33.51	82.81	36.32	0.992	9.89
Fertilizer: 11-48-0: 73 lbs/ac (81.8 kg/ha)	11.55	28.55		1.162	28.55
28-0-0: (liquid 34-0-0, costs adjusted)	21.17	52.32		6.452	52.32
Herbicide: Buctral M	5.03	12.44		0.165	12.44
HoeGrass (over 9.4% of area)	1.25	3.08		0.022	3.08
Seed: 70 lbs/ac (78.5 kg/ha)	5.40	13.35		1.068	13.35
Total costs/crop year	77.91	192.55		9.861	119.63
Income: Wheat @ 44 bu/ac (2959 kg/ha)				40.242	503.03
Net income				30.381	383.40

	Overall analysis of 2 year and 3 year systems	Gross Margin (partial)		Fuel use per rotation or per year	Net energy (partial to fuel, fertilizer, seed and herbicide)		
		$ per acre	$ per hectare	L/ha	GJ/ha	$/ha	
2 year system analysis	Gross income in a 2 year (items 1&2) system: 17.5 bu/ac/yr (1.177 tonnes/ha/yr)	161.95	400.18		32.016	[illegible]	N balance analysis 2 year system
	Total costs in a 2 year system	61.97	153.16	40.51	3.814	56.42	
	Net energy and gross margin	99.98	247.02		28.202	343.76	N removed = 57.82 kg/ha
	Net energy and gross margin per year	49.99	123.51	20.26	14.101	171.88	added as fertilizer = 4.93 kg/ha
3 year system analysis	Gross income in a 3 year (items 1&2&3) system: 26.3 bu/ac/yr (1.769 tonnes/ha/yr)	365.52	908.22		72.258	903.21	
	Total costs in a 3 year system	139.88	345.71	76.83	13.675	176.05	3 year system
	Net energy and gross margin	225.64	557.51		[illegible]	[illegible]	N removed = 130.50 kg/ha
	Net energy and gross margin per year	75.21	185.84	25.61	[illegible]	[illegible]	added as fertilizer = 103.39 kg/ha

1.3.4. Winter Wheat

Historically, production of winter cereals (oats, barley, soft and hard wheats, triticale, rye) with the exception of rye, have been excluded from Saskatchewan annual crops because such cultivars lack sufficient seedling cold-hardiness to survive most winter climatic conditions (Fowler and Gusta, 1981). Hardier varieties of winter wheat under conventional tillage practices (primarily summerfallow) have been grown for many years within the chinook belt of southern Alberta and to a limited extent immediately north of the U.S. border in the extreme southwestern area of Saskatchewan. However, two recent developments have contributed to winter wheat as a viable crop more or less throughout the prairie agricultural region.

- the introduction of the variety Norstar with improved winter hardiness approaching that of rye varieties. (Consensus of plant breeders is that further improvement of this genetic characteristic is limited)
- the recognition that the insulating effect of 8-10 cm of uniform snow cover attained through adopting minimum or zero-till seeding methods, leaving an effective standing stubble snow trap greatly enhances over-winter survival (Fowler, 1982, 1983).

Advantages of winter wheat over traditional spring wheats have been repeatedly cited in extension bulletins. Major benefits include a) a 15-30% higher yield, b) greater immediate yield response to nitrogen fertilization at rates above 55 kg/ha (Fowler, 1983) and c) good competition against wild oats and/or green foxtail (wild millet) usually

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*Page 32 has been deleted

eliminating the necessity for chemical control measures when satisfactory crop stands are established. These are relevant factors to the income return of winter wheat in comparison to other crops.

Much credit needs to be given to the University of Saskatchewan, Crop Development Centre; Canada Agriculture Research Stations; Saskatchewan Agriculture - chem-fallow project; Saskatchewan Pool Watrous farm and many cooperating farmers for demonstrating successful winter wheat cropping over several years. The formulated innovative farm practices have become reasonably defined (Fowler, 1983; Fowler et al, 1983). Interest has prompted a widespread increase in the number of grain producers devoting some acreage to winter wheat: production has risen from 688 hectares (1700 acres) in 1971/72 to a present estimate well in excess of 40,000 hectares (>100,000 acres). Eventual production level will ultimately depend on such factors as producer adjustment to less-conventional cropping systems, the crop remaining relatively immune to weed and disease problems (not fully known), and the ability of the Canadian Wheat Board to attain additional world markets.

Economic Considerations

According to a recent review (Harvey, 1981) approximately 70% of the world wheat trade involves winter wheat. Canada contributes about 4-5% to the world production holding some 16-18% of the world export trade. Harvey gave a comprehensive economic assessment of 5 Case Study Farms at various Alberta locations, growing winter wheat (1/12 to 1/2 of cropped acres) in 1/2:1/2 to near continuous cropping rotations. In all cases, winter wheat was more profitable than other crops in equivalent positions (i.e. fallow or stubble). While not an implicit objective of the study, overall returns among the farms increased with a higher proportion of winter wheat in extended length of cropping rotations. Similar conclusions are derived from a consensus research data approach publication for a typical 2000 acre southern Alberta farm in barley, spring and winter wheats production (Bunnage, 1983).

A partial budget economic comparison of winter and spring wheat production (1981 and 1982 crops grown) on 6 widely separated Saskatchewan farms has been recently reported (Rutherford and Fowler, 1983). Individual farms varied in their cultural management systems, ranging from an essentially zero tillage - straight combine operation for both crops to a cross-comparison with spring wheat under long established conventional tillage practices for both fallow and stubble situations:

FARM 1 Winter wheat on chemical fallow and on stubble, zero-till seeding, straight combine plus aeration drying harvest. Spring wheat identical to above, no wild oat or green foxtail control necessary for either crop.

FARM 2 Winter wheat on chemical fallow and on stubble, zero-till seeding, swath and combine harvest. Spring wheat on chemical-tillage combination fallow and on stubble, discer seeding, swath and combine harvest, complete chemical wild oat weed control.

FARM 3 Winter wheat on chemical fallow, hoedrill (1981) and zero-till (1982) seeding, swath and combine harvest. Spring wheat on tillage fallow, pretillage-DD press drill seeding, swath and combine harvest, spot post seeding rodweed wild oat control only.

FARM 4 Winter wheat continuous stubble cropping, zero-till seeding, straight combine plus propane drying harvest. Spring wheat continuous stubble cropping, discer seeding, swath and combine harvest, complete chemical control for wild oats and green foxtail.

FARM 5 Winter wheat continuous stubble cropping, zero-till seeding, straight combine plus aeration drying harvest, dessicant glyphosate (Roundup) spray application every third year prior to seeding.

Spring wheat continuous stubble cropping, zero-till seeding, straight combine plus aeration drying harvest, dessicant glyphosate (Roundup)-broadleaf tank mix spray application prior to seeding, post-emergence wild oat/green foxtail chemical control.

FARM 6 Winter wheat on barley or rape stubble, hoedrill seeding, swath and combine harvest.

Spring wheat on stubble, pretillage-hoedrill seeding, swath and combine harvest, post-emergence wild oat/green foxtail complete chemical control.

All farms employed phosphate fertilizer with the seed and broadcast nitrogen applications, plus broadleaf herbicides as late fall or early spring and in crop weed control measures. Farms 5 and 6 used identical nitrogen rates for both crops whereas others utilized higher nitrogen rates for winter wheat (i.e. attempt to gain from yield response).

A revised tabulation of apparent return margins wherein variable production costs are restricted to the major energy related input commodities (e.g. mobile fuels, fertilizers, herbicides) demonstrates an economic advantage for winter wheat over spring wheat (see Appendix for variance among farms).

Production Year Dollars/Hectare	CROP ROTATION POSITION Fallow Crop W.Wht	 Sp.Wht	2nd Crop Alternative W.Wht	 Sp.Wht	Continuous Crop W.Wht	 Sp.Wht
Gross Return	$ 475	358	460	336	408	294
Energy Cost	$ 103	64	65	71	102	127
Apparent Margin	$ 372	294	395	265	306	167
Productivity (Energy $/Tonne)	$ 38	35	23	36	39	71

The result principally arises from the high winter wheat yields and the elimination of costly wild oat/green foxtail herbicide control measures required on some farms for satisfactory spring wheat production. Inclusion of additional operating expenses in the comparison (per original report) does not alter these general conclusions. Notable however, is that the chemical fallow route to insure a stubble snow trap (most applicable to short rotations in the drier areas of the Brown soils) incurs a considerable add-on fallow-year herbicide expenditure in contrast to tillage summerfallow costs. Consequently the economics for winter wheat under this system are much reduced, at best marginal. Stubble cropping in the second or subsequent year positions appear as the most attractive option.

Energy Requirements

As reiterated throughout this report, concerns are directed to the evaluation of on-farm energy consumption in its various forms as related to activity sectors. In terms of annual cereals, oilseeds and contract cash crop production, the major components are in field operations liquid fuel useage, and in embodied forms of fertilizers, herbicides and insecticides (i.e. manufacturing process fossil fuel requirements). The magnitude of these yearly commodities consumed depends on a multitude of factors, among which are the specific crop mix, rotation length, varied management practices, and the proportion of grain-livestock on individual farm enterprises. These aspects are reviewed in more detail in Chapter 6, based on 1983 crop year data collected from this program's 22 participating farm cooperators.

Of interest here is the energy consumption and resultant energy productivity output of the less-conventional winter wheat systems compared to the same, or traditional, practices for spring wheat production.

	CROP ROTATION POSITION					
Production Year Per Hectare	Fallow Crop		2nd Crop Alternative		Continuous Crop	
	W.Wht	Sp.Wht	W.Wht	Sp.Wht	W.Wht	Sp.Wht
Mobile Liquid Fuel (L)	27.1	31.1	24.1	26.4	23.8	26.8
Total Energy (MJ)	4848	2390	5509	3879	7482	6003
Productivity (L/t)	9.3	15.2	8.3	13.1	9.1	15.3
(MJ/t)	1706	1221	1980	1973	2852	3398

*L - litres diesel fuel equivalents; MJ - megajoules; t - grain product tonnes.

In productivity terms, note that winter wheat uses less fossil fuel as liquid fuel, but more fossil fuel as N fertilizer derived from natural gas.

Readily apparent is the lower liquid fuel use per hectare requirements of the innovative systems. This, coupled with higher winter wheat yields, translates to about 9 litres per tonne output efficiency, in contrast to spring wheat in the 13 to 15 litres per hectare range. However, in total energy consumption, due to the nitrogen fertilizer applied, winter wheat is less conservative (note, except for Farms #5 and #6, disproportionately more N fertilization than spring wheat). While not shown, fertilizer inputs dominate all energy analyses. Excluding spring wheat fallow cropping systems (≅48%), it accounts for about 83% of the total energy outlay. Herbicides, a large item to the cost analysis, assume a minor proportion of the energy used, in the order of 5 to 8%. The remaining consumption, as indicated, is attributed to field operations liquid fuels.

Energy consumption averaged across the various managements, on a per product unit basis, suggests that spring wheat on fallow, under more conventional tillage practices, is the optimum choice from an overall energy conservation viewpoint. However in fairness, as herein analysed, fallow-spring wheat exploits the natural soil fertility*. The long-term sustainability of such a practice has been seriously questioned for some years; soil test evidence now show some fallow fields to be deficient in nitrogen for potential maximum yields. Future analyses of this type are more likely to show much closer comparison indices. For this study, where identical nitrogen fertilizer energy inputs were applied (Farms #5 and #6), winter wheat led in energy efficiency.

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* That is, there is a hidden energy cost to the spring wheat-fallow system, which is the depletion of soil nitrogen reserves. A 2000 kg/ha wheat crop removes over 40 kg N in the grain. To replace with urea would require about 2.9 GJ of embodied energy.

APPENDIX - Comparison of Apparent Energy Characteristics of Winter and Spring Wheats
Traditional and Non-traditional Cropping Systems (Farm Scale data; 1981, 1982)

Crop Grown	Rotation Position	Soil Zone	Farm No.	Gross Yield (kg/ha)	Est. Gross Value ($/ha)	VARIABLE ENERGY INPUTS: Mobile Fuels (dfe) (L/ha)	VARIABLE ENERGY INPUTS: Total Energy (fuel/fert/chem) (MJ/ha)	VARIABLE ENERGY INPUTS: Energy Cost ($/ha)	PRODUCTIVITY INDICES (1981, 1982 Crops*): Fuels (L/t)	PRODUCTIVITY INDICES (1981, 1982 Crops*): Total Energy (MJ/t)	PRODUCTIVITY INDICES (1981, 1982 Crops*): Cost ($/t)
W. Wht	Fallow	Brown	1	2336	384	26.1	4533	111	10.6	1838	45
Sp. Wht	Fallow	Brown	1	1514	238	25.3	2633	95	17.5	1821	66
W. Wht	Fallow	Dk. Brown	2	4136	632	27.6	3976	60	6.8	980	15
Sp. Wht	Fallow	Dk. Brown	2	2960	475	27.0	2119	52	9.4	735	18
W. Wht	Fallow	Brown	3†	2690	408	27.7	6036	137	10.6	2301	52
Sp. Wht	Fallow	Brown	3	2253	360	40.9	2419	46	18.7	1107	21
	Fallow Crop)-W. Wht			3121	475	27.1	4848	103	9.3	1706	38
	(averages))-Sp. Wht			2242	358	31.1	2390	64	15.2	1221	35
W. Wht	Stubble	Brown	1	2959	454	23.9	5568	61	8.3	1925	21
Sp. Wht	Stubble	Brown	1	1883	283	21.6	2034	60	11.9	1120	33
W. Wht	Stubble	Dk. Brown	2	3564	543	25.5	3760	48	7.3	1079	14
Sp. Wht	Stubble	Dk. Brown	2	2556	408	23.5	1790	36	9.5	722	14
W. Wht	Stubble	Black	6†	2555	382	22.9	7198	85	9.3	2932	35
Sp. Wht	Stubble	Black	6	2017	316	34.2	7813	119	17.3	4076	62
	2nd Crop Alternative)-W. Wht			3026	460	24.1	5509	65	8.3	1980	23
	(averages))-Sp. Wht			2152	336	26.4	3879	71	13.1	1973	36
W. Wht	Stubble	Brown	4	2690	408	23.8	9400	111	9.1	3584	42
Sp. Wht	Stubble	Brown	4	1681	266	28.9	5990	107	17.9	3711	66
W. Wht	Stubble	Dk. Brown	5	2690	408	23.8	5564	94	9.1	2121	36
Sp. Wht	Stubble	Dk. Brown	5	2018	321	24.6	6016	147	12.6	3085	75
	Continuous Crop)-W. Wht			2690	408	23.8	7482	102	9.1	2852	39
	(averages))-Sp. Wht			1850	294	26.8	6003	127	15.3	3398	71

*Fallow crops average of yield and inputs for 1981 and 1982 crops; all stubble crop comparisons relate to 1982 crop only (Farm #6 has 8 years of winter wheat experience).

†Farms most typical of present widespread tillage practices used in spring wheat production, hence best comparison to winter wheat minimum/ zero till "stubble in" system.

1.4. Skill in Farming is a Hidden Resource to Improve Energy Efficiency

Sometimes forgotten in studies of the technology of farming is the importance that the skill of the individual has on deciding crop yields. If skill makes the difference between a high yield and an average one, then, for similar investments in fuel and fertilizer, the more skillful farmer has increased his net income and his farm's energy efficiency, i.e. yield/fuel + fertilizer. This is shown strikingly in a study in Alberta of a large group of farmers growing canola (Thomas, 1983). A popular account of this study has been reported in Grainews by Loree (1983).

In an intensive study in 1981, 297 above-average canola growers filled out a detailed questionnaire about one of their canola fields. The survey was done in a way to minimize biases by soil type, climate and disease problems so that farmers in any one district could be compared with each other. To find out how some farmers achieved higher yields than others, a top yield group (average yield 40 bushels per acre) and a low yield group (21 bushels per acre) were selected from the total survey (average 30 bushels per acre). Differences between the groups in farming practices, including tillage, weed control, fertilizer use, and harvesting methods were surveyed.

What is remarkable about the high yield group is that they achieved their higher yields with only slightly higher costs for fuel, fertilizer and herbicides than the low group. This is encouraging in that the techniques of the high yield group could likely be adopted by others with little extra cost in dollars or energy.

A rough estimate has been made of differences in costs and energy use between the top and low group to relate this to differences in net energy production. Our analysis follows:

Practice	Comments
1. Low group had more who planted canola on canola stubble (15%). None of top group did.	Those who did not have canola in the previous 4 years had higher yields (30 bu/ac) than those who did (28 bu/ac).
2. Low group had a higher percentage who didn't know what their soil texture was.	
3. The top group had more (25%) who practiced minimum tillage than the low group (5%).	Top group would be expected to have less fuel use but higher herbicide costs.
4. The top group did more tillage operations in the fall. They made fewer passes with tillage equipment and more with harrows, fertilizer and herbicide applicators. The top group applied fertilizer and herbicide more in the fall than the low group. The low group carried out more tillage in the spring.	The top and low groups would likely not use significantly different amounts of fuel for tillage. The fewer the tillage operations in the spring, the higher was the yield (1 tillage: 32 bu/ac, 4 tillages: 28 bu/ac), reflecting better spring surface moisture conservation.
5. The top group appeared to do a better job of seed bed preparation, particularly for stubble crop. They achieved a firmer seed bed and retained more moisture near the surface to enhance seed germination.	There was a 4 bu/ac advantage to having a firm seed bed compared to a slightly loose seed bed.
6. The top group seeded the larger Argentine varieties deeper on the average. They used more airflow and hoedrills then aid the low group. The top group seeded Polish varieties more shallowly on firmer seed beds than the low group.	

7. The top group used more pedigreed seed (90%) compared to the low group (60%).	Top group would have higher seed costs. Use of pedigreed seed gave a 2 bu/ac yield advantage.
8. More of the top group used a dual insecticide-fungicide seed treatment than the low group.	Seed treatment costs would be higher ($1.08/ha, $0.44/ac) for the top group. Dual treatment gave a 3 bu/ac yield advantage over no treatment.
9. Fertilizer appeared to be the area where the top group used more energy intensive inputs than the low group. The difference between the two groups was not as large as the yield differences might suggest. For stubble crop (72% of canola was grown on stubble) the top group applied more nitrogen (77 lbs vs. 56 lbs). They used more anhydrous ammonia, the cheapest source, they applied more in the fall, when fertilizer tends to be cheaper (we assumed 10%), and they deep banded more (100% vs. 67% for the low group).	

The sum of these effects is shown in the following table (Table 12 next page) (figures in brackets are in acres).

In summary, for fertilizer:

- The top group spent $6/ac more on $N+P_2O_5$.
- They invested 17% more energy in fertilizer.
- They got 90% more yield (for many reasons besides the amount of fertilizer used).
- Their net income was almost double that of low group.
- They got 39% more canola per unit of fertilizer energy invested than did the low group.

On average over 5 years the top group had yields 50% higher than the low group indicating that they consistently were doing some things better.

Table 12. Differences between top and low group canola producers in energy costs of fertilizer relative to yields.

	Low group		Top group	
	$/ha	GJ/ha	$/ha	GJ/ha
Costs of N, including application costs	31.03	4.14	37.82	4.76
Cost of P_2O_5 (mainly spring applied with seed)	14.23	0.21	23.42	0.34
Total costs	45.26	4.35	61.24	5.10
Costs per acre	(18.32)		(24.78)	
Yield of canola (tonnes/ha)	1.177 (21 bu/ac)		2.242 (40 bu/ac)	
Gross income ($/ha)	403		767	
Gross margin (gross income-fertilizer costs) ($/ha)	358		706	
Gross margin ($/ac)	(145)		(286)	
Fertilizer energy costs per tonne of canola (GJ/tonne)	3.70		2.27	

Fertilizer Use Management

A canola yield of 40 bu/ac (2.242 tonnes per hectare) represents a much higher N fertilizer demand than a 21 bu/ac (1.177 tonne/ha) yield. Would the top group have to fertilize more next year since they depleted soil reserves more? Without analyzing soils it is not possible to decide. Based on the N fertilizer used, the N in the seed harvested, and an assumed available soil N of 25 kg N/ha (stubble fields) before planting canola, the relative efficiency of using soil and fertilizer N is 69% (top yield group) and 46% (low group), assuming soils were depleted to the same final level.

On average the top group put on 36.5% more fertilizer, and, on a 5 year average, get 50% more crop. Thus their average fertilizer efficiency appears to be 37% better, assuming the soils were depleted in N to the same final level by both groups.

Further general comments on practices continues:

Practice	Comments
The majority of the canola growers used Treflan for weed control. The top group used slightly more. The top group also applied a little more post emergent herbicides. The top group seem to achieve better incorporation of herbicides at the right stage of weed growth, and had somewhat better weed control. Some 45% of the low group said they had moderate to heavy weed problems versus 5% of the top group. Moderate weediness caused a 3 bu/ac drop in yield, and heavy weediness a 7 bu/ac drop in yield.	The top group spent on average \$32/ha (\$12.90/ac) on Treflan and Avidex versus \$20/ha (\$8.10/ac) for the low group. In energy terms the high group invested 54% more energy (0.32 GJ/ha) in herbicides. In investment per tonne of canola produced, the low group invested \$17, the high group \$14.
The top group swathed earlier at a higher seed moisture and had less losses due to shattering. Combine losses were not large for either group. The top group had less dockage (3.7%) than the low group (9.4%) due to greater weed problems in the low group.	Top group would get slightly higher prices per tonne due to less dockage.
With a yield of 2.242 tonnes (40 bu/ac) per hectare for the high group versus 1.177 tonnes per hectare (21 bu/ac) for the low group, there would be extra fuel costs for combining and seed hauling for the top group.	The estimated extra fuel costs for truck hauling a crop to the grain bin are as follows: (next page)

		Low Group	High Group
Yield (kg/ha)		1.177	2.242
bu/ac		21	40
Truck hauling 3.2 km (2 miles)			
	L/ha	2.65	5.04
	GJ/ha	0.103	0.195
Cost	$/ha	0.97	1.85
	$/ac	0.39	0.75

It was not possible to locate much data on the extra fuel costs for combining a crop with double the yield. If the fuel consumption increased 20%*, i.e. from 9 L/ha to 10.8 L/ha, the extra cost would be $0.65/ha ($0.27/ac) or about 0.07 GJ/ha.

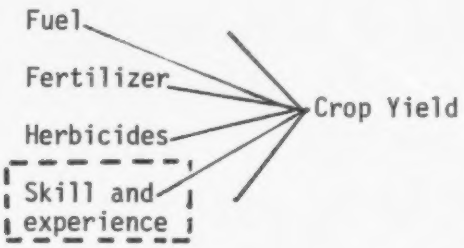
*Suggested by R.A. Dodds, Agric. Eng. Dept., Univ. of Saskatchewan (1984)

In summary, the top group spent a little more on energy intensive inputs, mainly fertilizer, but gained a much higher yield:

- They spent $16/ha ($6.50/ac) more on fertilizer.
- They spent $12/ha more for herbicides.
- They spent $1/ha more for seed treatment.
- They spent $1/ha more for extra truck fuel for hauling more crop to storage (with perhaps a further $1 for extra combine fuel costs).
- Total extra costs, $30/ha ($12/ac), were used, along with the skill and experience of the farmer, to almost double the yield in 1981.
- Gross income of the top group would have been $767/ha (1983 December prices) compared to $403/ha for the low group. The low group had about the same yield as the average for the province.

- Our estimate is that the top group invested about 16% more energy, mainly as extra fertilizer, to get a 90% increase in yield in 1981, and a 50% increase in yield on average over the last 5 years. The magnitude of the yield difference seems more than could be attributed just to the extra N and P fertilizer used by the high yield group, based on other studies of the yield response of canola to fertilizer. Thus, application of 100 kg N/ha gave a canola yield of 2042 kg/ha compared to 1918 kg/ha when 25 kg N/ha was applied (Nuttall and Ukrainetz, 1983), all other nutrients held constant. This yield response is much less than that observed in the Alberta study, where many other yield factors are assumed to be operating.

It appears that the yield increase in the Alberta study was as much due to extra skill and better management of the top group of farmers as it was to more use of energy as fuel, fertilizer, and herbicides:



The following table (Table 13) shows the differences between top and low group in how productively they used energy. [The machinery investment, i.e. the energy required to manufacture the machinery used (tractors, combines, trucks, etc.), corrected for the rate of depreciation, was assumed to be the same for the two groups].

Table 13. Summary of Variable Energy Inputs into Growing Canola in Alberta in 1981.
Differences between Top Group and Low Group of Farmers.

Inputs and Yields	Energy Investments and Yields	
	Top Group	Low Group
	GJ/ha	
Inputs		
Fuel		
34 L/ha base fuel use[1]	1.335	1.335
2.4 L/ha extra truck hauling	0.093	
1.8 L/ha extra combine fuel	0.070	
Total	1.50	1.34
Fertilizer	5.10	4.35
Herbicides	0.89	0.59
Total[2]	7.49	6.28
Yields		
Yield canola (minus seed for seeding)(tonnes/ha)	2.235	1.170
Energy investment GJ/tonne	3.35	5.37
Net energy production (GJ/ha) (yield[3] - variable energy inputs of fuel, fertilizer and herbicides)	43.0	26.4
Energy ratio (product ÷ variable inputs)	6.74:1	4.21:1
Energy ratio (product ÷ all inputs including machinery investment estimate)	6.03:1	3.69:1

---

[1] Average fuel use for 3 Saskatchewan farms in 1982 including trucking hauling to storage bins on farm.

[2] Not including energy investment represented by machinery. This is estimated to be 0.88 GJ/ha (Goering and Daugherty, 1981) for both groups.

[3] Assumes an energy value for canola seed of 22.6 MJ/kg based on the gross caloric value of the vegetable oil and the metabolizable energy of the meal for pigs (Zuk et al., 1981).

1.5. Energy Losses Associated with Summerfallowing

Nitrogen Fertility Losses from Fallow Land Due to Leaching and Volatization

1.5.1 Leaching Losses

Recent studies have shown that there can be very considerable leaching losses of nitrate-nitrogen from soils, especially during periods of above normal rainfall. The losses are particularly severe from summerfallowed land, as was shown in a recent study at Swift Current by Campbell and Zentner (1983):

In 1982, rainfall was 20% above average and it was estimated that fallow soils lost 150-200 kg N/ha due to leaching. If urea fertilizer was used to replace this lost N:

. Costs would be $90-$120 per hectare ($36-$49/ac) (Spring, 1983 prices)

. Energy costs would be 10.9-14.5 GJ/ha.

This is the energy equivalent of 280-375 litres of diesel fuel per hectare. This is about 10 years worth of fuel to grow a crop on this land.

Losses of nitrate-N due to leaching were much less when:

. Crops were grown continuously or where there were rotations that included fall seeded crops (e.g. fall rye).

. Nitrogen fertilizer was applied according to soils tests. This was presumed to be due to the positive effect of fertilizer N on plant N uptake.

1.5.2 Volatization Losses

Losses of soil nitrogen can also occur due to reductive and oxidative soil processes which convert soil nitrate to nitrous oxide and nitrogen gases which escape into the atmosphere. A recent study in Saskatchewan (Aulakh, Rennie and Paul, 1982) found gaseous nitrogen losses of 1-3 kg N/ha/year from land growing wheat crop, but a rate of 10 kg N/ha/year from land in summerfallow. While this volatility loss from summerfallow fields is not as large as the leaching losses reported by Campbell and Zentner (1983) it is still significant. A 10 kg N loss/ha/year is equivalent to:

. A loss of $6 of fertilizer ha/year ($2.40/ac) (as urea-N)

. An energy loss (calculated as urea N) of 730 MJ/ha, which is the equivalent (in energy terms) to that contained in 19 litres of diesel fuel. This amount of fuel is about the same as that required to cultivate that hectare of land in the summerfallow year. Thus there can be a "ghost" litre of fuel silently being lost to the air as N fertility losses for every litre actually burned to cultivate the summerfallow!

1.6. Energy Costs of Manufacturing of Nitrogen Fertilizers: Recent Improvements

The energy required to manufacture nitrogen fertilizers has dropped substantially since 1947. The energy cost of making urea decreased 23% between 1955 and 1975. The shape of the curves of rate of improvement in energy efficiency of manufacture suggest that further improvements in efficiency could be expected in the future (Smil, Nachman and Long, 1983). Between 1980 and 1982, Canadian nitrogen fertilizer manufacturers reduced natural gas needed to make a tonne of ammonia by 17 percent, and have a goal of a total of 31 percent reduction by 1985 (Petruic, 1982).

The difference between urea and ammonia (see Table 1, page 4) shows that there are also differences between different N fertilizers in the energy costs. Choice of fertilizers and changes in the mix with time could change and decrease the energy used to provide N fertilization.

Since ammonia is also cheaper in dollars than urea, this can also affect choice of fertilizers. However, other factors can affect fertilizer use, such as special equipment and precautions needed for use of ammonia. Since ammonia has to be deep banded, fuel costs will be higher than for broadcasting solid fertilizers such as urea. However, recent studies have demonstrated advantages for many fertilizers of deep banding. If deep banding becomes the method of choice of applying fertilizer then ammonia would not be expected to be at a disadvantage to other fertilizers by reason of method of application.

1.7. Deep Banding to Increase the Efficiency of Use of Nitrogen Fertilizers

1.7.1 Effect of Deep Banding Compared to Broadcasting

There have been many studies on methods to increase the efficiency of use of nitrogen fertilizers under the conditions of the Canadian prairies. Recent Soil and Crops Workshops at the University of Saskatchewan (see reports for 1982, 1983 and 1984) have described many of the improvements being made. One of the chief methods which improves N fertilizer efficiency (i.e. yield of grain per unit of fertilizer N applied) is deep banding. Some of the advantages reported are:

. Less loss of urea from decomposition and volatization.

. More effectiveness when surface soil is dry - fertilizer is not stranded in the top soil, roots are encouraged to go deeper, to moister soil, to obtain nutrients.

. Yields are higher than from broadcast.

Extra costs are:

- need to rent extra equipment to deep band,
- higher fuel costs to deep band compared to broadcast.

The effects are analyzed in Table 14 for the results of 16 separate dryland trials carried out in western Canada between 1979 and 1981 (Harapiak, Flore and Timmermans, 1982).

Table 14. Influence of nitrogen fertilizer and time of application on yield, income and energy (yields derived from Harapiak et al., 1982.

	Fall Applied			Spring Applied		
	Check	Broadcast	Banded	Check	Broadcast	Banded
Yield (kg/ha)	1770	2260	2450	1880	2280	2530
Income and Costs per hectare:						
Gross income[1]	301	384	417	320	388	430
Custom rate costs[2]	-	4	15	-	4	15
N fertilizer costs[3]	-	45	45	-	50	50
Gross margin to fertilizer N and application	301	335	357	320	334	365
Energy effects per hectare						
Yield (GJ)	24.07	30.74	33.32	25.57	31.01	34.41
Extra fuel costs (GJ)	-	0.07	0.18	-	0.07	0.18
N fertilizer costs (GJ)	-	6.11	6.11	-	6.11	6.11
Partial net energy (yield - fuel and N) (GJ)	24.07	24.56	27.03	25.57	24.83	28.12

[1] Wheat @ $170/tonne

[2] Custom rate costs for N application

[3] Urea @ 60¢/kgN, 54¢/kg in fall (10% less), applied 84 kg N/ha

Both in dollars or energy terms, the deep banding showed advantages over the broadcast method, although more dollars and fuel had to be invested to gain these advantages.

1.7.2. Effect of Different Rates of Fertilizer N Combined with Deep Banding

A Farm Lab experiment on the McAllister farm in 1982 (Rennie et al., 1983) demonstrated the effects of the rate of N fertilizer application on the response of a wheat crop to deep banding fertilization. Urea was deep banded in the fall at a rate of 60kg N/ha. A very wet spring (flooding) suggested that some urea N had been lost prior to spring seeding. Therefore, more urea was added in the spring at the rates shown in Table 14a. The urea N was deep-banded at 8-12 cm depth between every other seed row with a precision press drill designed for simultaneous seeding and deep banding of fertilizer. Phosphorous fertilizer (11-51-0) was placed with the seed (30-35kg P_2O_5/ha). The seeding was done into standing stubble of the preceding crop.

The results in Table 14a clearly show that there is an optimum rate of application of fertilizer N beyond which yields and net energy fell off. In terms of total energy expenditures for fuel, fertilizer, and herbicides, excessive rates of N fertilizer application would have a major negative effect on net energy of food production, as much as not enough.

Table 14a. Effects of Different N Fertilizer Rates by Deep Banding

Rate of Urea N Application kg N/ha	Yield of wheat kg/ha	Gross food energy of wheat	N fertilizer energy	Net energy
		- - - - - - - - -	GJ/ha- - - - - - -	- - - - - - -
60	2428	33.02	4.36	28.66
90	3489	47.45	6.54	40.91
120	3576	48.63	8.72	39.91
135	3160	42.98	9.82	33.16
150	3128	42.54	10.91	31.64

1.8. Legumes as a Source of N Fertilizer Energy

1.8.1. Green Manure and Forage Legume Crops: N Fertilizer Benefits

Several years ago Bentley (1978) made the observation that one of the main objectives for western Canadian agricultural research was to develop good cropping systems for including legumes for western Canada. He estimated that about 25% of the nitrogen in food and feed in the United States came from biologically fixed nitrogen (e.g. soybeans, forage crops, and peanuts) whereas the comparable figure for Canada was 3-5%.

Markets for pulse crops may be expected to grow, and varieties of soybeans suitable for western Canada are being developed and introduced; such trends could make a significant contribution to utilization of seed legumes into cropping systems. However, markets for pulse crops seem unlikely to grow fast enough to make such crops a major source of biologically fixed nitrogen for the whole western Canadian agricultural economy in general, at least in the near future. For individual farms, however, such crops could make a major contribution to N fertility needs (see section 1.8.2. page 59).

Forage crops such as alfalfa have been known for many years to contribute to soil fertility. For forage crops, such as alfalfa, which have expensive seed, it is assumed that several years of hay are harvested before a final growth of tops is plowed in. The accumulated growth of roots, plus the final top growth, is the source of the N fertilizer for following crops. In the black and grey wooded soils, where lack of soil moisture is not usually a serious problem, such forage plowdown can make a significant positive contribution to the yield of a following cereal crop. Table 15 shows recent Farm Lab results from northwestern Saskatchewan.

Table 15. Alfalfa plow-down in the gray soil zone (Marcelin, Saskatchewan). Energy and economic benefits (yields and fertilizer data from Rennie et al., 1983)

	N fertilizer (kg/ha)	Alfalfa plow-down			Stubble crop		
		0	60	90	0	60	90
Yield	Grain yield (kg/ha)	2439	2351	2756	1236	2406	2321
	protein (%)	14.1	16.2	16.2	10.9	12.9	13.5
Income:							
	Income	414.92				403.65	
	N fertilizer costs					36.00	
Income - N costs		414.92				367.65	
Energy:							
	Food energy produced (GJ/ha)	33.2				32.7	
	N fertilizer energy (GJ/ha)	0				4.4	
	Net energy relative to fertilizer						
i.e. food energy-) N Fert. energy)GJ/ha		33.2				28.3	

Assumptions:

Wheat value	#1 CW >13.5% protein	$170.12
(Table 3)	#1 CW	167.17

Nitrogen fertilizer used: urea @ $0.60 per kg N (Table 2)

Energy values:

Wheat: metabolizable energy of grain as food
: 13.6 MJ/kg (Southwell and Rothwell, 1977)

Urea, per kg N: 72.7 MJ/kg (Table 1)

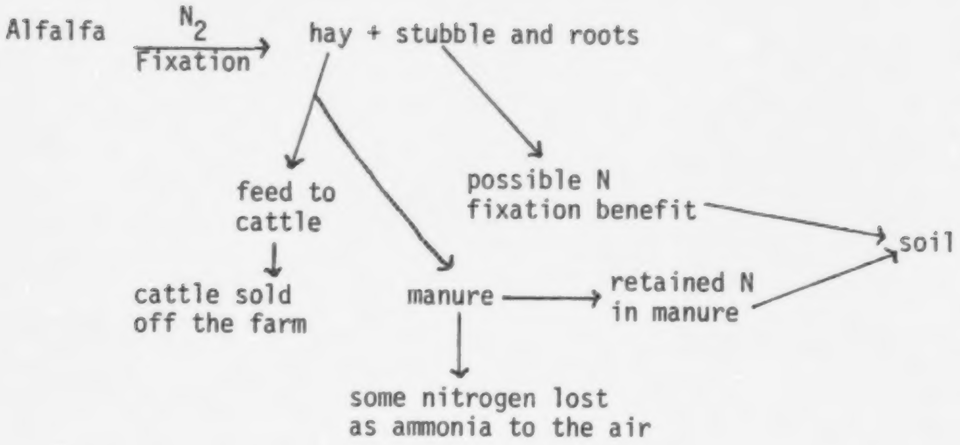
These costs ($ and energy) would have to be adjusted, in any complete analyses, for differences in tillage costs between alfalfa plow-down and wheat stubble tillage.

The amount of fertilizer N energy saved is 4.4 GJ/ha. This is roughly four times the energy in fuel which would have been required to grow and harvest this wheat crop. Thus the amount of energy saved is very considerable.

During the years in which the forage is growing and being harvested for hay, little or no N fertilizer is needed; N fertilizer energy is saved for those years of the rotation also. The Alberta Forage Seed Council (1983) estimated that in 3 years (establishment plus 2 years of hay production) alfalfa might fix 394 lbs. of N/acre (442 kg N/ha) on gray luvisol soils, and 153 lbs. of N/acre (172 kg N/ha) on black solod soils. An N fixation rate of 442 kg N/ha/3 years = 147 kg N/ha/year. As urea, this is worth $88 per year, in energy terms = 10.7 GJ/ha/year.

On many of the Farm Energy Management Farms, about 25 litres of fuel per hectare were required to grow and harvest a wheat crop. At current farm prices this would cost $9.15/ha/year. Thus $88 (N fixation $ benefit of alfalfa) would purchase over 9 years worth of fuel to grow and harvest a wheat crop.

On some soils in Alberta this hay residue N fixation benefit was not observed (Hoyt and Leitch, 1983), while on other soils a large benefit was seen. In this study, the hay was harvested and was assumed to be sold off the farm. However, for farms which have cattle which are fed the hay, some further benefit would be assumed to be obtained from the incorporation of manure back to the soil.


Alfalfa
N_2
Fixation
hay + stubble and roots
feed to cattle
cattle sold off the farm
possible N fixation benefit
soil
manure
retained N in manure
some nitrogen lost as ammonia to the air

A long term study of a crop rotation including alfalfa and recycling manure to the system (Spratt, 1966) showed significant cost and energy savings over a cereal only rotation (Boerma, Gimby and Coxworth, 1980).

The problem with inclusion of forages in rotations is that they are mainly limited to situations where cattle are available nearby to utilize the hay. For many farmers without cattle, or not able to have markets for pulse crops, green manure use of legume crops appear to be the main option for obtaining the benefits of N_2 fixation.

A preliminary assessment as green manure crops of a number of annual legumes (field peas, lentils, faba beans, Tangier flat pea) found that faba beans and field peas gave the highest rates of N_2 fixation (Townley-Smith and Slinkard, 1984). However the seed costs of field peas and faba beans cancelled out the benefits of N_2 fixation. When field peas, lentils and faba beans are grown as pulse crops, i.e., for the seed, the negative effect of high seed cost is not as serious a problem as when trying to use them as green manure crops.

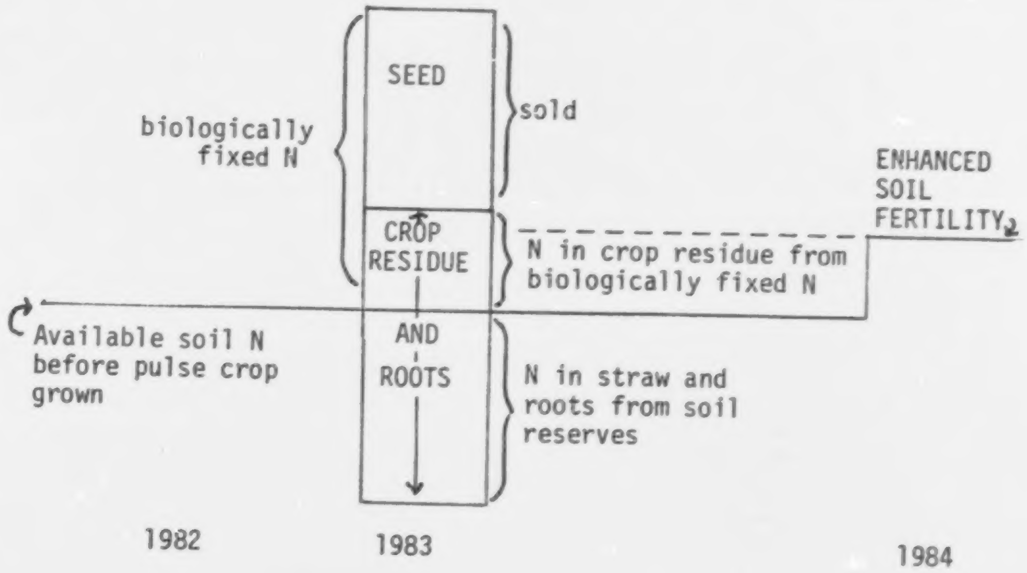
Red clover has been used as a green manure crop, especially in more northern areas. An analysis of a group of farmers using red clover as a green manure crop in the Westlock district northwest of Edmonton was done recently (Baier, 1982). Red clover was substituted for some of the barley acreage in a canola-barley-wheat continuous cropping rotation. Canola was used as the nurse crop for the red clover. Wheat planted after the clover plowdown required only phosphorus fertilizer and yielded slightly higher than stubble crop wheat following barley in a continuous cropping system without red clover. An economic analyses of the two systems showed an advantage for the system including the red clover green manure:

Cropping rotation	Gross Operating Profit (Gross returns minus direct costs of fuel, fertilizer and herbicides, depreciation and labour)	
	$/ha	$/ac
Canola-red clover-wheat-barley	16.63	6.73
Canola-wheat-barley	2.32	0.94

This result is partly due to the fact that in 1981 (the year the analysis was done) the economic value of barley and the costs of production were such that conventional barley production lost money. By removing some land from barley production, and saving on costs of nitrogen fertilizer for wheat, the overall gross operating profit was increased.

1.8.2. Fertilizer Benefits to Crops Following Pulse Crops (nitrogen-fixing) in Rotations

Pulse crops such as lentils, field peas and faba beans can biologically fix most of their nitrogen fertilizer requirements. After the pulse seed is harvested, will the pulse crop residue and roots, as they decompose, provide nitrogen fertilizer for a following crop, from residual biologically fixed nitrogen, over and above any nitrogen derived from soil reserves?


SEED
sold
biologically fixed N
ENHANCED SOIL FERTILITY
CROP RESIDUE
N in crop residue from biologically fixed N
Available soil N before pulse crop grown
AND ROOTS
N in straw and roots from soil reserves
1982
1983
1984

A recent study begun at the Melfort Experimental Station of Agriculture Canada (Wright, 1984) indicates that under the 1983 conditions, pulse crop residues can confer considerable benefits on the yield of a following barley crop.

In this experiment, faba beans, field peas, lentils and barley were sown in 1982 on canola stubble. After harvest of the seed, crop residues were left standing in the field. In 1983 all plots were sown with an o-till drill to barley, and 5 different rates of nitrogen (urea) were broadcast on separate sub-plots. Phosphorus fertilizer was applied to all plots at the same rate (45 kg P_2O_5/ha).

The results are shown in Table 16 taken from preliminary results of Wright (1984). We have calculated the energy implications at two rates of N, the first at 0 kg N/ha, representing the benefit of the crop residue alone, the second at 84 kg N/ha, the recommended rate of N application for barley grown on barley stubble in this experiment.

Table 16. Energy and Income benefits of pulse crop residues to a following barley crop. (Preliminary results from Melfort, Wright, 1984).

	Barley Grown on the Stubble of:			
	Barley	Field Pea	Lentil	Fababean
No N Fertilizer:				
Yield of barley (kg/ha)	2700	3025	3115	3175
Gross Income ($/ha)	370	414	427	435
Estimated rate of urea N application on barley stubble to achieve yield on pulse crop residue (kg N/ha):	-	43	61	73
Dollar savings/ha	-	26	37	44
Energy savings (GJ/ha)	-	3.1	4.4	5.3
N Fertilizer @ 84 kg urea N/ha				
Yield of barley (kg/ha)	3200	3820	3820	3955
Gross Income ($/ha)	438	523	523	542
Gross margin to) fertilizer N)($/ha) costs of $50/ha)	388	473	473	492
Return to) fertilizer N) investment) $crop/$urea N)	8.76	10.46	10.46	10.84

Assumptions: Barley @ $137/tonne : Urea @ 60¢/kg
: Barley sown o-till into stubble of the preceding crop.

The two-year effect (pulse crop year and stubble carry over) of having field peas, lentils or faba beans in rotations, on overall fertilizer requirements, could be considerable. If pulse crops replaced barley, which needs 84 kg N/ha, and only required 6 kg starter N themselves, then the two year effects would be:

	field peas	lentils	faba beans
N saved (2 yr) kg/ha	121 (43+84-6)	139 (61+84 6)	151 (73+84-6)
$ saved (urea N) $/ha	73	83	91
Energy saved (GJ/ha)	8.8	10.1	11.0

If we consider a 5-year cropping system (e.g. for the Melfort area) what would be the savings of including field pea (for example) in the rotation, in terms of fertilizer N dollars and energy saved?

Assume: (I) Fallow-wheat-canola-field peas-barley

Compare to:(II) Fallow-wheat-canola-barley-barley

Assume yield of barley with 15 kg N after field pea residue = barley yield with 84 kg N after barley (see Table 16).

Fertilizer N requirements (estimate):

Rotation I: 0 + 20 + 84 + 6 + 15 = 125 kg N

Rotation II: 0 + 20 + 84 + 84 + 84 = 272 kg N

Savings estimated = 147 kg N (54%)

Dollar savings (urea N) = $88 per hectare

Energy savings = 10.7 GJ

These savings do not take into account other costs of substitution, e.g. need for markets for the pulse crops, herbicides for weed control, disease control, cost of seed.

These results do suggest that there are considerable benefits to explore with rotations including pulse crops. While Dr. Wright has cautioned that his results are very preliminary (1983 results only on carry-over effect of pulse crop residues) they are a promising lead for further research and testing.

1.8.3. Potential Role of Legumes. General Comments.

World-over the merit of including legumes among crop sequences has had a long-standing recognition. Utilization of the so-called free atmospheric nitrogen for their own growth, a variable ability to contribute nitrogen to the soil reserve for subsequent crops, in addition to other soil improvements is reasonably well understood (Alberta Forage Seed Council publ.; Bowren, 1977; Hanley, 1980; Grevers et al, 1982, Slinkard, 1984; Coxworth et al, 1978; others). The purpose of this section is an overview of the potential substitution of legume derived nitrogen for commercial fertilizers from the perspective of fossil fuel and related farm cost savings.

1.8.3.1. Brief Background Review

Essentially since establishment, Agricultural Stations have researched the role of legumes in prairie cropping situations, initially perennial or biennials as forages/green manuring (alfalfa, clovers or grass mixes) and more recently locally adopted annuals (grain legumes e.g. peas, fababeans, lentils, soybeans, continued search for others). Crop rotation evaluations inherently require long periods, being somewhat subject to natural fertility decline trends and further confounded by nitrate soil mobility and denitrification processes. Since nitrogen is the primary nutrient for grain yield, crop response in either the subsequent year or over a rotation cycle has been mostly used as the judgement criteria (now supplemented by soil nitrogen and moisture testing.

In general, climatic moisture conditions have a major influence on the acceptability of legumes in crop rotations. While long term studies (principally forages) have demonstrated some yield benefit viewed over the rotation term for all soil zones, it varies from at best marginal (Brown/Dark Browns) to acceptable, but inconsistent, responses within the more moist soil zones (Blacks also experience subsequent first cropping yield loss during drier years). Legumes, when managed as forages or green manures are best suited to long grain-forage rotations on degraded or grey wooded soils (Bowren, 1977; Hanley, 1980; Campbell per comm - Research Station crop rotation summaries). For the most part, past approaches to legumes has been one of an immediate cash crop return e.g. livestock feed, seed production, alfalfa pellet market, rather than as a nitrogen fertilizer substitute. Over a large portion of the province (Thin Black, Dark Brown, Brown zones) the trend to more specialized livestock operation, the expeditious nature of commercial fertilizers and importantly, the well-known yield reduction of subsequent crop, has discouraged the use of forage and green manure legumes. For the none-livestock producer, forage legumes, due to their induced moisture stress effect, do not integrate well into short 2 or 3 cropping rotations.

1.8.3.2. Possible Expectations

Suggested extension of cropping rotations, with their need for additional nitrogen inputs, accompanied by an escalated energy consumption and farm cost, has revived interest in legume utilization. Some orientation comments, translating specific crop N requirements into equivalent commercial fertilizer embodied energy (i.e. manufacture), and farm cost values, are in order. This is illustrated here for the three major prairie crops as adapted from the 1981 edition of Guide to Farm Practice. The embodied nitrogen fertilizer energy value and cost are those for urea, consistent with calculations elsewhere in this report (anhydrous ammonia approximately 20-25% lower). The effect of three assumed nitrogen imput levels are shown.

Crop	Nitrogen Required (kg/ha)	Assumed Commercial Fertilizer Required					
		Embodied Energy (MJ/ha)			Approx. Farm Cost ($/ha)		
		25%	50%	75%	25%	50%	75%
Wheat (40 bu/ac)	95	1727	3453	5180	14	29	43
Barley (60 bu/ac)	101	1836	3671	5507	15	30	46
Canola (35 bu/ac)	118	2145	4289	6434	18	35	53

MJ = Megajoules energy. % = % of total N met by fertilizer

Apart from moisture limitations (Browns and portions of the Dark Brown zones), the energy and economic consequences of extended rotations requiring additional nitrogen, is readily apparent. The question at hand is how annual or biennial legumes might resolve both the energy consumption-farm cost and soil deterioration issues of the much maligned present crop-fallow system.

From an overall fertilizer productivity viewpoint, some indication of consumption levels during the early period of wider use can be derived from data on wheat, barley and canola in fallow and stubble crop positions covering the 1966-76 period (Halstead, 1981). Yield comparisons for fertilized and unfertilized practices are quoted for each of the six soil zone classifications. As indicated, on average, both fallow and stubble crops received 20 kg/ha P_2O_5, and 7 and 25 kg/ha N respectively. In the analyses here, embodied fertilizer energy values for 11-51-0 and 34-0-0 were used, i.e. common fertilizers in use during the reference time period. Yield responses and the estimated fertilizer energy productivity, in megajoules per tonne (averaged across all the soil zones) are presented below.

Crop	Fallow Response		Stubble Response	
	Yield (kg/ha)	Energy Use (MJ/t)	Yield (kg/ha)	Energy Use (MJ/t)
Wheat	368	3450	314	10710
Barley	503	2570	506	8370
Canola	258	5620	-	-

A significantly larger energy commitment due to additional nitrogen is demonstrated for stubble cropping. Since this point in time, fertilizer useage has increased, with a larger proportion of annual energy inputs associated with fertilizer forms (≅33-66%). A more recent update is given in Chapter 6, obtained from the 1983 Farm Energy Management Program participating farm survey.

More relevant to the topic is the efficiency of nitrogen fertilizers per se. Nitrogen responses are highly dependent on timing and modes of application associated with soil moisture regimes; yield responses may top out in the 60 to 120 kg N/ha range of fertility application*. A recent estimate (Rennie and Wilkinson, 1984) indicates 1 kg of N as applied fertilizer nitrogen produces 6 to 10 kg of grain. This corresponds to an energy productivity of about 12,100 to 7,300 megajoules per tonne. Farm-Lab experimental winter wheat plots during 1983 tentatively revealed a much improved wheat product nitrogen efficiency, in the order of 17-18 kg grain per kg N (≅4000 MJ/t energy output productivity). Approximately 20 kg of grain per kg N is currently regarded to be about the upper limit, i.e. irrigation prairie agriculture.

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* see page 1.53 of this Chapter.

The extent to which legumes can substitute for inorganic nitrogen is influenced by the selected legume and manner of management in the crop rotations. Expected average amounts of nitrogen fixed by appropriately inoculated legume species (Coxworth et al, 1978; Slinkard, 1984) range from 45 to 115 kg/ha for annual grain legumes and from about 119 to 210 kg/ha for perennial/biennial forages under favorable growth conditions. Perennial alfalfa poses establishment problems, and should be maintained for 2 or more years for best results, hence is not too suitable for the non-livestock grain producer. Biennial clovers are potentially as good under a green manuring practice using an early season incorporation (≅mid-June) for the most optimum nitrogen contribution-moisture depletion trade-off. Harvesting of forages or annual grain legumes drastically reduces nitrogen additions to the soil, at best 10 to 20 kg/ha, and seriously depletes soil moisture reserves for the following year's crop (Bowren and Cook, 1974; Hanley, 1980; Slinkard, 1984). Annual grain legumes are more suited to stubble cropping under moderate to low soil nitrogen conditions, since little or no fertilizer nitrogen is required (i.e. their ability to utilize upward to 50% of satisfactory yield requirements from the atmosphere N source). Grain legumes residue readily decomposes but contribute little nitrogen; hence after such crops the soil reserve is similar to that after cereals*, in addition to a reduction in soil moisture (Hanley 1980, Slinkard 1984). Consequently, annual legumes are in reality more of a low nitrogen requirement crop alternative to cereals for stubble cropping (Hanley, 1980). High seed cost or value of home-grown equivalent more or less excludes annuals from a green manuring practice.

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* For a recent example which somewhat contradicts this assumption see Section 1.8.2.

A few literature examples are tabulated to illustrate the potential energy and farm cost savings. They are of a cursory nature, in general compared on the basis of approximately similar crop yields after legume managements compared to commercial fertilizer applications.

Source Reference	Legume Supplied N (kg/ha)	Savings Fertilizer Energy (MJ/ha)	Savings Farm Cost ($/ha)
Grevers, deJong (1982)	56-112	4070 - 8148	34 - 67
Bowren, Cooke (1975)	76	5530	46
Bowren (1977)	21	1530	13
Rennie (1984)	21	1530	13
Campbell (per comm, 1983) (Brandon, barley-legume rotation)	90	6540	54

A more intense search would have added to the list. Unfortunately, studies were reported in a variety of comparative parameters, making direct comparisons to commercial nitrogen fertilizer somewhat elusive. Focal points of comparisons may relate to internal rotation cultural practices, subsequent crop yield or protein content, whole plant versus root only potential decomposition nitrogen, available nitrogen and moisture soil test interpretations, etc. Many of these interacting factors are still a part of on-going research. A comprehensive treatment along this report format would require careful attention to rationalizing data to a common criterion yardstick. Most likely legumes can be of some advantage, but not an entire substitute, for commercial inorganic mitrogen where maximum production is the objective.

1.8.3.3. Status Quo or Innovative Cultural Practices

Prevalent throughout this discussion has been the recognized yield loss on cereals/oilseeds resulting from forage legumes inclusion in crop rotation. For the northern region of the province, where soil moisture is less of a limiting factor, present practices can be retained to advantage, primarily from a cash crop outlook, i.e. livestock-grain operation, saleable legume seed, alfalfa pellet export, with soil nitrogen fertility as a secondary benefit. Yield reduction frequency would appear to be within tolerable limits over much of the area. Elsewhere, mixed farms, by adopting longer rotations or partial utilization of underseeded clovers as feed, can achieve similar benefits, but probably to a lesser extent.

Grain producers without livestock or a convenient forage product market appear to have two alternatives.

a) Evaluate the economics of green manuring yield loss relative to nitrogen fertilizer costs. Under restricted grain markets and escalating nitrogen prices, such a cash flow trade-off option may be periodically attractive if the average production reduction is not too severe (notably, a few FEMP farms appear to be taking this approach, particularly on their poorer quality soils).

b) Alternately, adopt some form of snow-trapping technique which will in total or part alleviate the soil moisture reserve problems associated with partial fallow green manuring or other forage managements. A number of unique practices with potential adaptation to 2 or 3 year rotations of the Dark Brown soil zone are under active investigation (Foster, per comm.). The experimental program is not yet sufficiently advanced to provide definite conclusions. An estimate of energy and economic characteristics for preliminary trials at two locations are given in the accompanying tables (17 and 18). All treatments received soil test recommended phosphate but no additional nitrogen fertilizer. The presented analysis includes the total energy consumption and cost for field operations fuels, phosphate fertilizers and herbicides according to methods described in detail in Chapter 6.

TABLE 17. MODIFIED 3-YEAR ROTATION (PRELIMINARY TRIAL), 1981-82 SUTHERLAND HEAVY CLAY. SPRING WHEAT-SWEET CLOVER ROTATIONS

FALLOW YEAR TREATMENT DESCRIPTIONS	GROSS YIELD (kg/ha)		ENERGY CHARACTERISTICS			ENERGY COSTS			APPARENT RETURN MARGIN
			CONSUMED	PRODUCTIVITY(MJ/t)		CONSUMED	PRODUCTIVITY($/t)		
	WHEAT	CLOVER	(MJ/ha)	WHEAT	CLOVER	($/ha)	WHEAT	CLOVER	
Conventional Tillage[1]	2670	--	2723	1020	--	49	18	--	413
Disc Incorporation (partial fallow)	2737	--	3249	1187	--	102	37	--	372
Hay Forage Harvest (clear-cut, no tillage)	2307	4450	3235	1402	197	81	35	≈2	673[3]
Hay Forage Harvest (snow-trap strips, no tillage)	2296	4005	3143	1369	201	80	35	≈2	636[3]
Spray Dessication (≈July 1, no tillage) Spring Wheat	2809	--	2992[4]	1065[4]	--	118[4]	42[4]	--	369[4]
Clover Seed Harvest[2] (no fall tillage)	2576	2576	2355	914	--	69	27	--	377

[1] Representative conventional tillage fallow and crop on same site area (not part of formal experiment)

[2] Clover left to maturity in this trial, i.e. not harvested.

[3] Includes a clover hay forage value, year of harvest.

[4] Where a good clover stand is established and/or volunteer grains, wild oats, green foxtail weeds are not a problem, dessication can be accomplished with less energy and cost by 2,4-D treatment. Values then become 2457 MJ/ha, 874 MJ/t, 73 $/ha, 26 $/t for an apparent return margin of $414.

TABLE 18. MODIFIED 3-YEAR ROTATION (PRELIMINARY TRIAL), 1982-83 BRADWELL LIGHT LOAM. WHEAT-SWEET CLOVER ROTATIONS

FALLOW YEAR TREATMENT DESCRIPTIONS	GROSS YIELD (kg/ha)		ENERGY CHARACTERISTICS			ENERGY COSTS			APPARENT RETURN MARGIN
	WHEAT	CLOVER	CONSUMED (MJ/ha)	PRODUCTIVITY(MJ/t) WHEAT	PRODUCTIVITY(MJ/t) CLOVER	CONSUMED ($/ha)	PRODUCTIVITY($/t) WHEAT	PRODUCTIVITY($/t) CLOVER	
Conventional Tillage	2665	--	2702	1014	--	88	33	--	375
Disc Incorporation (partial fallow)	2936	--	2673	910	--	87	30	--	423
Hay Forage Harvest (clear-cut, no tillage)	1188	1667	2592	2182	116	87	73	1	444
Hay Forage Harvest (snow-trap strips, no tillage)	1401	1467	2573	1836	122	87	62	1	442
Spray Dessication (≈July 1, no tillage)									
Spring Wheat	1750	--	2480 [1]	1417 [1]	--	103 [1]	59 [1]	--	196 [1]
Winter Wheat	2199		2506 [2]	1140 [2]	--	104 [2]	47 [2]	--	252 [2]
Clover Seed Harvest (no fall tillage)	1559	270	2649	1699	1703	87	56	16	341

[1] Where 2,4-D dessication satisfactory (see explanation Table 17), values become 2287 MJ/ha, 1309 MJ/t, 87 $/ha, 50 $/t for an apparent return margin of $213.

[2] Similarly, 2313 MJ/ha, 1052 MJ/t, 88 $/ha, 40 $/t for an apparent return margin of $267.

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Chapter 2

Farm Case Studies: Survey of Conservation Activities

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Revitalized soil and improved cash flow . . . . 2.A.1.

Chapter 2

Farm Case Studies: Survey of Conservation Activities

2.1 Introduction

As a start on the technology transfer proposed in Phase III, a simple energy audit form was developed and tested. Figure 1 shows the audit format and entries for a two-family grain farm near Swift Current.

One of the owners[*] was interviewed to get his opinion of the potential for energy conservation. Here are some of his comments:

1. Good opportunities for conservation exist in the farm transportation category, especially non-loaded travel.
2. Doubtful if it would pay to use diesel grain trucks for the small distances travelled.
3. Already does gear-up/throttle down (originally for reduced noise level).
4. Tune-ups done regularly on all engines.
5. Expects to continue the trend to less tillage and more "once-over" operations (air-seeders and discers are both efficient machines for multi-job applications).
6. Interested in eliminating fall tillage.
7. Development is needed of a reliable tractor efficiency monitor to show percent slip and power output per litre of fuel. This would assist the operator adjust depth, speed, etc. for best performance.

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[*] Not one of the 21 farmers involved in the Farm Energy Management Program.

Energy Type	(Purchased 1982)	Cost	Main Uses
Marked Gasoline	14,500 L. (1,390 GAL.)	$4,350.	2 half-ton trucks 3 grain trucks 1 swather 1 combine
Clear Gasoline	8,013 L. (1,763 GAL.)	2,964.	3 cars
Diesel Fuel	7,053 L. (1,552 GAL.)	2,116.	3 tractors
Oil and Grease	---	400.	Tractors and Vehicles
Heating Oil	9,851 L. (2,167 GAL.)	2,955.	2 homes
Electricity	15,680 kWh	627.	1 farmstead 2 homes 1 shop
		$13,412.	

Figure 1 Simple Energy Audit:

This is an energy audit for a 648 ha (1600 acre) grain farm near Swift Current, Saskatchewan. The audit shows that the main energy cost on this farm is for the gasoline used in cars and trucks. Diesel fuel use in tractors is quite modest due to the minimum tillage practiced in the region.

This example illustrates the importance of analyzing all energy costs whether incurred for farm or personal use. Potential savings in the farm home and transportation categories are often as great as in the production sector.

8. Dirty or rusted cultivator shovels increase draft by at least 25% for many hours before they scour clean.
9. A lot of fuel gets used for cleaning. A high pressure steam cleaner may save energy.
10. Agrees that most farmers could easily save 10%

2.2 Development of an Energy Management Checklist

On the basis of such interviews with farmers, and the many reports and articles on the subject, it was decided to prepare an energy management checklist, emphasizing the many small or medium magnitude management changes (Large changes in cropping practices were handled separately - see Chapters 1 and 6).

The most profitable areas of energy management on any farm are the free and low-cost conservation measures which can be easily adopted. Because these ideas have little glamour they are often ignored in favour of more exciting but unproven renewable technologies.

The simple conservation ideas shown in the accompanying checklist can save 10 to 30% of the energy cost on most farms. Their values applied to all Saskatchewan farms, even at a 10% reduction in energy use, would save about $40,000,000 per year.

The checklist was derived from a larger study and manual being preared (by N.E. Jensen) for Agriculture Canada as an energy management guide for farms across Canada. The farm energy management program offered an opportunity to test the energy management ideas suggested in the guide.

A simplified checklist was prepared, derived from the larger, more complex manual. This simple checklist was tested with most of the farmers involved with our study. We were interested in answers to the following questions:

1. What changes have already been made?
2. What energy management techniques are (a) most popular, (b) least popular?
3. What are the reasons some techniques have been rejected?
4. What actions might be taken in the future?

We believed the results obtained with these farms (probably more energy conscious than the average) would be useful in extension activities to other farms.

The following two pages give the checklist which was tested with the farmers on the program:

2.2.1. ENERGY MANAGEMENT CHECKLIST

ACTION	COST	SAVINGS/YR. (SAMPLE FARM)	APPLICATION ON YOUR FARM?
A. FARM HOME			
1. Lower the furnace thermostat by 1°C (2°F)	NIL	$90.00	
2. Lower the hot water thermostat to 50°C (122°F)	NIL	$60.00	
3. Use less hot water	NIL	$58.00	
4. Turn off lights when not needed	NIL	$40.00	
5. Use smaller wattage light bulbs where adequate	NIL	$35.00	
6. Shop for energy-efficiency when replacing appliances	NIL	$50.00	
7. Weatherstrip and seal cracks	$200.00	$200.00	
8. Insulate basement	$500.00	$100.00	
•			
•			
•			
•			
B. FARMSTEAD			
1. Reduce unnecessary lighting	NIL	$50.00	
2. Plug in block heaters for only (2-3) hours	NIL	$30.00	
3. Shade fuel tanks to reduce evaporation	NIL	$80.00	
4. Paint fuel tanks a light color	?	$25.00	
5. Install pressure relief valves	?	$30.00	
•			
•			
•			
•			
C. CARS AND TRUCKS			
1. Reduce unnecessary travel (1 less trip to town per week)	NIL	$200.00	
2. Reduce idling	NIL	$100.00	
3. Drive 8 km./hr. slower	NIL	$100.00	
4. Keep tires at maximum recommended pressures	NIL	$50.00	
5. Operate engines at maximum recommended temperatures	NIL	$200.00	
6. Do more frequent tune-ups	$25.00 ?	$200.00	
7. Shop for energy-efficiency when replacing vehicles	NIL	$500.00	
•			
•			
•			
•			

ACTION	COST	SAVINGS/YR. (SAMPLE FARM)	APPLICATION ON YOUR FARM?
D. TRACTORS			
1 • Reduce idling	NIL	$100.00	
2 • Ballast for correct slippage	?	$200.00	
3 • Match equipment for efficient operation	NIL	$150.00	
4 • Gear up/throttle down for light loads	NIL	$200.00	
5 • Shop for fuel efficiency when replacing tractor	NIL	$500.00	
•			
•			
•			
•			
E. CROP PRODUCTION			
1 • Eliminate fall tillage	NIL	$500.00 ?	
2 • Reduce depth of tillage	NIL	$500.00 ?	
3 • Reduce field operations	VARIES		
4 • Improve field patterns	NIL		
5 • Soil test for fertilizer applications			
6 • Use legumes as nitrogen source			
•			
•			
•			
•			
F. LIVESTOCK PRODUCTION			
1 • Reduce lighting	NIL		
2 • Check thermostats	NIL		
3 • Select efficient equipment	VARIES		
•			
•			
•			
•			
G. GENERAL			
1 • Apply for rebate on gasoline excise tax	NIL	$277.00	
2 • Use 50% tax writeoff for heat recovery equipment	NIL		
3 • Use 50% tax writeoff for manure storages and equipment	NIL		
4 • Use 100% tax writeoff for land drainage improvements	NIL		
•			
•			
•			

2.2.2 Testing the Checklist

Eighteen of the cooperating farmers were interviewed to evaluate the checklist. It was found that these farmers have taken advantage of the majority of the low cost or no cost conservation techniques suggested in the checklist. As a rule, practices that increase energy efficiency tend to be readily accepted as long as they are consistent with the overall efficiency of the farm. It is important to note that energy conservation was not always the overiding motive for making these changes; i.e., a new vehicle was often bought without energy efficiency in mind, but better fuel efficiency was achieved because of changing manufacturing standards.

The following general comments refer to the categories listed in the checklist.

A. - Four farmers mentioned that when they reduced water temperature the dishwasher would not work properly.

- Two farmers mentioned that it was difficult to reduce lighting because small children would forget to turn the lights out.
- Several farmers mentioned installing fluorescent lights to reduce cost. There is a great deal of interest in the new fluorescent bulbs which screw into incandescent sockets.
- There are six houses on the project farms which have been built within the last three years. Energy conservation has been a major consideration in the design. Several energy efficient partial retrofits have been done on houses of farmers in the project.

B. - Two farmers mentioned that they would not reduce block heater plug-in time because they wanted to have the vehicle ready to go at all times (calving, in the middle of the night, etc.).

- Many farmers wanted information about timers for block heaters.

C. - Farmers with children mentioned that it was difficult to reduce miles travelled.

- In many cases farmers said that they would not drive slower (time is money) but would instead opt for more fuel efficient vehicles.

D. - Many farmers questioned the idea of reducing idling of their tractors because of fears of engine damage.

- Most farmers said that fuel efficiency was not the major factor when buying a new tractor. The deal that could be made and dealership reliability are of much greater concern than energy conservation.. Tax considerations are also important for some farmers when buying new equipment.

E. - Many of the farmers in the program have moved to more continuous cropping rotations which reduces energy requirements for summer fallow but increase energy requirements for fertilizer.

- A few farmers mentioned they are unable to eliminate fall tillage because they are unable to get on the land in the spring if they do not.
- Avedex application and working in manure requires that the land be worked in the fall.

- Many farmers mentioned that they are reducing the number of summer fallow operations from the number of operations done a few years ago when fuel was cheap.
- Many farmers have buried rock piles and torn out fence lines etc., to make way for bigger equipment which has resulted in better field efficiency.
- Not many farmers do field tests on every field on an annual basis because they find recommendations are about the same from year to year.

F. - Some farmers are buying more energy efficient equipment and many are taking a long look at the entire feed system (a couple of farmers commented that silage is a big energy user).

G. - No comments.

The summary of the results of farmer interviews is given in Table 1. By comparison with the checklist, the reader can obtain an idea which conservation actions have already been taken, which ones are not popular and why, and which activities are likely to be tried in the future.

A high percentage of the farmers are already doing many of these energy conservation activities. Interesting questions arise from the results of these interviews:

- How typical of all Saskatchewan farmers are the farmers on the study?
- Since our farmers are likely more energy conscious than average (they were chosen on the basis of their interest in farm energy management), is it likely that many of the actions already taken

GUIDE TO TABLE 1.

A. FARM HOME

1. Lower the furnace thermostat by 1°C (2°F)
2. Lower the hot water thermostat to 50°C (122°F)
3. Use less hot water
4. Turn off lights when not needed
5. Use smaller wattage light bulbs where adequate
6. Shop for energy-efficiency when replacing appliances
7. Weatherstrip and seal cracks
8. Insulate basement

B. FARMSTEAD

1. Reduce unnecessary lighting
2. Plug in block heaters for only (2-3) hours
3. Shade fuel tanks to reduce evaporation
4. Paint fuel tanks a light color
5. Install pressure relief valves

C. CARS AND TRUCKS

1. Reduce unnecessary travel (1 less trip to town per week)
2. Reduce idling
3. Drive 8 km./hr. slower
4. Keep tires at maximum recommended pressures
5. Operate engines at maximum recommended temperatures
6. Do more frequent tune-ups
7. Shop for energy-efficiency when replacing vehicles

D. TRACTORS

1. Reduce idling
2. Ballast for correct slippage
3. Match equipment for efficient operation
4. Gear up/throttle down for light loads
5. Shop for fuel efficiency when replacing tractor

E. CROP PRODUCTION

1. Eliminate fall tillage
2. Reduce depth of tillage
3. Reduce field operations
4. Improve field patterns
5. Soil test for fertilizer applications
6. Use legumes as nitrogen source

F. LIVESTOCK PRODUCTION

1. Reduce lighting
2. Check thermostats
3. Select efficient equipment

G. GENERAL

1. Apply for rebate on gasoline excise tax
2. Use 50% tax writeoff for heat recovery equipment
3. Use 50% tax writeoff for manure storages and equipment
4. Use 100% tax writeoff for land drainage improvements

2.2.3 Table 1 Summary of Interviews with 18 Farmers of the Energy Management Checklist

CHECKLIST CATEGORY #	TRIED AND REJECTED	ARE DOING	NOT TRIED AND WON'T	MIGHT	WILL TRY
A. 1	-	16	2	-	-
2	4	5	3	3	3
3	-	18	-	-	1
4	4	17	-	-	-
5	-	14	2	1	1
6	-	12	1	-	-
7	-	17	-	-	1
8	-	13	-	2	3
E=141	6/4%	112/79%	8/6%	6/4%	9/6%
B. 1	-	8	3	7	-
2	2	11	-	2	3
3	-	3	-	11	4
4	-	9	-	-	-
5	-	12	1	4	1
E=81	2/3%	43/54%	4/5%	24/30%	8/10%
C. 1	3	6	4	-	5
2	-	-	-	-	-
3	-	11	1	2	4
4	2	6	5	-	5
5	-	12	-	2	4
6	-	9	-	6	3
7	-	18	-	-	-
E=105	5/5%	62/59%	10/10%	10/10%	21/20%
D. 1	-	14	2	1	1
2	-	7	1	2	8
3	-	17	1	-	-
4	-	14	2	-	2
5	-	3	15	-	-
E=90	-	55/61%	21/23%	3/3%	11/12%
E. 1	-	11	4	-	-
2	-	18	-	-	-
3	-	14	1	3	-
4	-	9	-	9	-
5	-	13	4	1	-
6	-	6	10	2	-
E=105	-	71/68%	19/18%	15/14%	
F. 1	-	4	2	-	2
2	-	6	3	-	1
3	-	2	-	6	-
4	-	-	-	-	-
5	-	-	-	-	-
E=105	-	71/68%	19/18%	15/14%	
G. 1	-	16	2	-	-
2	-	1	17	-	-
3	-	-	-	-	-
4	-	-	-	-	-

by these 18 farmers remain to be adopted by many other farmers? If so, there is considerable opportunity to save other farmers money (and energy) in the future.

2.2.4. Designing the Farm Energy Management Guide from Which the Checklist was Derived

The plan was to give the farmer enough information to enable him or her to make a decision about a particular energy conservation subject without overwhelming the individual with too much data.

The manual was divided into the following categories:

- Farm Energy Management
- Farm Home
- Farmstead
- Transportation
- Tractors
- Crop Production
- Livestock Production
- Renewable Energy

Within a category a further subdivision was made:

e.g. Farm Home:

- Construction
- Lighting
- Retrofitting
- Appliances
- Space Heating
- Habits
- Water Heating

Each subdivision would have one to several examples of particular energy conservation or energy management actions which could be considered.

The following page gives an example (farm fuel storage) of the format used. It gives the basic information to make a decision, where to get more information, and a bit of background on the particular subject.

For a particular farmer, ag rep, farmstead engineer, or policy maker, the manual and the generalized sheet used with the farmers on the Farm Energy Management Program, could be used in several ways:

1. They can help identify actions which could save dollars and energy.
2. They could help make decisions about what to do first, and how to make a plan for future actions, as time and finances permit.
3. As more and more farmers used the forms, ag reps and engineers could get a good idea which conservation actions were popular, which needed technical improvement to make them more feasible, and which actions needed financial incentives to aid their more rapid introduction (if desired).
4. As we get an idea, from testing these manuals and and sheets with other farmers, which action are not adopted yet by the average farmer, but are likely to be over the next five years, policy makers can estimate the energy savings which are likely to be achievable. As part of the follow

FARM ENERGY MANAGEMENT ANALYSIS

SUBJECT	FARM FUEL STORAGE
OBJECTIVE	To reduce fuel evaporation loss from an above-ground gasoline storage tank.
ACTION REQUIRED	(1) Paint tank white or silver. (2) Provide shade protection. (3) Install pressure relief valve.
COST	$100 (?)
EXPECTED SAVINGS	Measurements of summer evaporation from a 1135 L. tank showed that the above measures reduced losses from 36 L/month to 5L/month. Assuming average year-round savings of (20L/mo. x 12 mo.) = 240 L/year. Annual savings = 240 L x 30¢ = $72.00 Payback = 1.4 years.
OTHER THINGS TO CONSIDER	PRO Better fuel quality.
	CON
MORE INFORMATION	Fuel Storage - How To Avoid Problems And Save Money. Booklet available from Federated Co-operatives Limited, 401 - 22nd S-reet E., Saskatoon, Saskatchewan S7K 3M9.

up, it should be possible to estimate energy savings which could be achieved if farmers adopted these energy conservation measures. This should give an indication of the magnitude of the energy efficiency improvements achieveable.

The complete farm energy management guide is being prepared on a separate contract by one of us (N.E.J.) to Agriculture Canada. It is anticipated that copies of the guide will likely be available before the end of Year III of this project.*

2.3. Final Farmer Comments and Plans

During the last month of the project, farmers were asked to evaluate the effect of the Farm Energy Management Program, and to indicate the types of changes they had made, or planned to make. Future plans of the project team include attempting to quantify changes already made, and follow the effect of changes planned in the future.

The following example gives one farmer's comments on the project and his energy conservation activities and plans. The farm is in the dark brown soil zone near Regina. The farmer is also a participant in the Farm Lab project (results of a fertilizer placement study on this farm are given on page 1.53 (Chapter 1).

Complete reports of this type on all farms will be given in the final version of this report.

The Appendix to this chapter (reprinted from Farm Light and Power) gives an example of results from one of the other farms (#8) on the project.

---

* In final stages of preparation as of April, 1984.

The following questions were asked the farmers participating in FEMP.

FARM #5

Q. Has participation in the Farm Energy Management Program revealed any surprises on your farm?

A. We are surprised at the high gasoline consumption for transportation.
- the fuel meters made us more conscious of costs per acre.

Q. What changes have you made in energy use during the past three years?

A. We built a new energy-efficient house.
- energy efficiency was a decision factor when purchasing a new tractor.
- we try to get away with just three summerfallow operations when we used to do four.
- no more fall cultivation.
- we cultivate at a lesser depth.
- we are gearing up and throttling down.
- aeration drying bins were installed in 1983.

Q. What changes do you expect in the next three years?
- we will be continuing to move towards more continuous cropping.
- we will use more anhydrous ammonia when conditions are right. We are conscious of the large nitrogen loss from spreading 46-0-0 in the fall during warm weather.
- we will attempt to trap snow if we experience a very dry fall.
- I will trade in my 1974 Ford 1/2-ton for a new one.
- I will be installing turbine ventilators on the house (Venmar).

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Revitalized soil and improved cash flow

Farmers are often faced with bewildering choices for improving energy efficiency on their farms. Motor vehicles, cropping systems, buildings — all offer possibilities for energy savings. Many energy conservation measures add up to savings that really count.

Just ask Wayne Newport. This Marsden, Sask. farmer has witnessed a significant decrease in his farm energy consumption. The reasons: decreased energy use, making more efficient use of fertilizers, and implementing a continuous cropping system on his land.

By DARYL OSHANEK

Wayne Newport examines his air seeder in anticipation of spring field work. It has helped Newport reduce his energy costs associated with cultivation.

CONTINUOUS cropping is a relatively new concept on the Newport farm. It's improved the farm's cash flow and it's a program that has put some life back into the soil.

"When our land was in summerfallow, we experienced some salinity problems. With continuous cropping we've stopped that migration of salts which the summerfallow was drawing. For farmers with saline land, I think continuous cropping can almost eliminate that problem," Newport said.

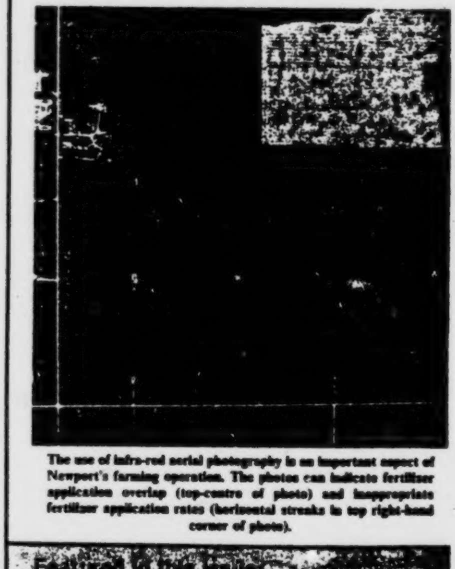
The continuous cropping program on the Newport farm includes the planting of 1500 acres of oilseeds and 1500 acres of cereal crops each year. Direct seeding into the previous year's crop residue was a healthy way to conserve the soil, Newport commented. Continuous cropping also eliminated pre-seeding tillage.

Newport added that tilling less often resulted in improved soil conservation, a build-up of organic soil matter, less soil erosion from wind and water, and lower fuel costs.

* * *

MARSDEN IS A small community a few miles east of the Alberta/Saskatchewan border south of Lloydminster. Newport said many farmers now are using a 75 percent crop to 25 percent summerfallow rotation on their land.

"The die-hard 50/50 club are starting to consider planting more seed into stubble crop. Those leery of continuous cropping point to the fact that they grow 45 bushel wheat crops. But split that over two years and you're getting only about 22 bushels. If you grow steady, you could probably grow a 32 bushel crop each year," Newport added.



The use of infra-red aerial photography is an important aspect of Newport's farming operation. The photos can indicate fertilizer application overlap (top-centre of photo) and inappropriate fertilizer application rates (horizontal streaks in top right-hand corner of photo).

He continued: "If you pencil it out, you are probably a few dollars ahead and have helped build organic matter in the soil. You've probably improved the soil conditions by not robbing or mining the organic matter off that soil."

Newport has been aided in his quest to improve the soil's quality with the use of an air seeder. He believes the days of the double disc press drill are numbered. The air seeder allows farmers to seed their crop more efficiently into stubble than traditional methods, he explained.

He found that an air seeder was less expensive to buy than a press drill. It also saved a farmer time and energy costs.

"A press drill 40 feet in length costs about $60,000. An air seeder and cultivator costs about $40,000. The air seeder can do a number of jobs such as banding fertilizer, chemical placement, and cultivation. The press drill was meant only to do one thing. We've cut our operating expenses considerably using the air seeder, with no drop in yields," Newport commented.

Accuracy of the seeding rate using an air seeder was great, said Newport. His air seeder works on a speed and shaft principle. He said it was ideal for getting seed into ground that wasn't worked black.

* * *

THE MARSDEN FARMER has always maintained that farmers wasted too much energy — himself included. His concern for energy conservation was heightened three years ago. At that time he was one of 21 Saskatchewan farmers chosen to participate in a farm energy management program sponsored by the federal and provincial governments.

Purpose of the program was to determine how much energy is was being used on the farms, and what specifically, it was being used for. It also aims to help farmers improve their net incomes in one of two ways: Either by cutting costs by making more efficient use of fuel and fertilizers; or by increasing income by increasing yields without large extra energy costs.

The program allowed Newport to experiment with continuous cropping. It also helped him appreciate more fully the advantages of air seeding.

"But what really helped us cut our energy costs on the farm was the practice of gear up — throttle down. By gearing up and throttling down to match our tractor power output to the load, we were able to reduce our fuel costs by about 15 percent," Newport said.

Another idea was the use of infrared air photos. This is something Newport used last year and wants to use again this spring.

Infrared air photos provided a wealth of useful information to the farmer, according to Newport. He said the photos could indicate germination patterns, fertilizer distribution, drainage possibilities, weed and herbicide problems. "These photos can also show the differences in fertility within a field," Newport said. "Knowing precisely where soil is deficient in organic matter and nutrients allows me to place additional fertilizer exactly where it is needed."

The farm energy management program also helped Newport make some changes to buildings on the farm. He's in the process of developing an energy efficient home and has installed a combination furnace-wood stove in his shop. The shop ceiling has also been fitted with rotary fans with the electricity supplied by Sask Power. The fans move heat trapped in the ceiling to the floor.

* * *

IT'S IRONIC that Newport should even have to be concerned with energy conservation. Situated within the boundaries of his farm are five oil

(Continued Next Page)

Featured in this Issue:

Tillage and weed control

Reprinted with permission of Farm Light and Power.

2.A.2.

Improved soil and higher profits

(From Previous Page)

wells. He's paid $1500 per well each year by the oil company. But Newport added that the concept of a farmer getting rich off the wells was not true.

"With the wells we are limited to strip farming. It takes us three hours longer to do the same quarter of land now with four wells on them. You consider the time, the cost of additional chemicals, and overseeding and it all adds up," stated Newport.

"They are like putting a slough in a field. Every farmer knows how much a slough costs," stated Newport.

* * *

ENERGY CONSERVATION, like farming in general, has been a learning experience for Newport. His grandfather farmed the land in the 1920s. Newport took over the farm after his father's death in 1966. Things had changed since he saw his father last work the land, he commented.

Newport: Oil wells are like putting a slough in the middle of a field.

"There is very little incentive today for the young person to get involved in farming unless he inherits the farm from his father. The young man who wants to get ahead has got to read the markets and be able to go to the bank with a cash flow that says the operation will float if it rains," Newport said.

With little incentive for people to get into farming and with the average age of farmers around 50 years, Newport often finds himself thinking what farming will be by the turn of the century.

"You look at where our farm has come from, to what it is today, to where it will be if my son takes over the operation. Hopefully I can encourage him to be a farmer. I'll have to show him that it's no bed of roses, but it's a good life."

Newport is always happy to talk about new farming practices with neighbours and friends. If you'd like to talk to him about his farming operation just phone (306) 826-5653.

Chapter 6

Current Annual Cropping Energy Consumption and Related Cost Characteristics

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Chapter 6

ABSTRACT

This chapter gives an overview on the actual energy use for fuel, fertilizer and herbicides, all related specifically to crop production, on the participating FEMP farms.

Fuel use increased as the percent of cultivated land in crop (as distinguished from summerfallow) increased. However, the productivity of fuel use, as measured by litres of fuel per tonne of wheat produced, changed very little.

As the cropping system was intensified, i.e., more stubble cropping, nitrogen fertilizer use increased rapidly, and replaced fuel as the No. 1 energy related cost.

The methods and accounting forms used could be employed by many farmers to evaluate and monitor fuel, fertilizer and herbicide costs on their own farm. Changes and new cropping systems, such as those described in Chapter 1, could then be related to the actual energy use on the farm with present practices.

Considerable differences in energy use were observed between individual farms using similar cropping systems. Further detailed studies would be needed to evaluate how much of these differences were due to relative effectiveness of conservation methods, and how much was due to soil and climate.

Chapter 6

Current Annual Cropping Energy Consumption and Related Cost Characteristics

Introduction

Agricultural mechanization, essentially initiated on a widescale some 40 years ago, has been accompanied by an escalated demand on the world supply of petroleum fossil fuel resources. During it's early phase, annual cropping energy requirements were almost exclusively for gasoline in direct field tillage, planting and harvesting operations (some 2,4-D broadleaf weed control and phosphate fertilizer use also beginning to be adopted); later trends have been to more fuel efficient diesel power units. Subsequent on-going technological advances have produced a host of effective herbicides and a recognition that nitrogen fertilizers are increasingly needed to achieve optimum stubble crop yields. More common use of these varied commodities adds to the overall cropping energy consumption total because of embodied energy consumed in such products through basic feed stock and manufacture. The primary purpose of this section is to review apparent current levels of mobile liquid fuels, fertilizers and herbicide/insecticide useage as directly related to cereals, oilseeds and contract cash crop production in Saskatchewan.

6.1 Energy Expenditure and Distribution Overview

The analysis sections to follow are based on information derived from 21 participating Farm Energy Management Program (FEMP) farms. The FEMP farms were selected on the basis of widespread location and diversity of enterprises. Accordingly, this is reflected in energy purchases as fuel, fertilizer and herbicides and in their percentage of total farm expenditures (Gimby *et al*). Approximate distribution of energy use is shown in Table 1.

Table 1. Energy Characteristics of Farms Studied

	Approximate Energy Farm Cost Percentage			
Farm Type	Mobile Fuels	Fertilizers	Heating Fuels	Electricity
Grains (St. grain) (8)	39	53	3	5
(grain/market garden) (1)	82	10	0	8
Mixed (grain/beef or hogs) (9)	42	39	9	10
(grain/dairy) (1)	45	34	2	19
Ranching (1)	78	∼0	11	11
Dairy (1)	60	1	2	37

( ) number of farms in class

Mobile fuels-gasoline and diesel; Heating-propane, natural gas, wood.

	Approximate Sector Percentage (1980) Farm Energy			
Farm Type	Production	Transportion	Domestic	Expense(%)
Grains (St. grain) (8)	21	7	2	29
(grain/market garden) (1)	12	14	4	30
Mixed (grain/beef or hogs) (9)	15	6	3	24
(grain/dairy) (1)	10	4	<1	14
Ranching (1)	3	5	2	10
Dairy (1)	3	<1	<1	4

( ) number of farms in class

Evident is the reduction of energy cost importance as the operations engage in less grain production income sources. Similarly, energy forms vary considerably as related to principal activities (adapted 1980, '81, '82 averages; Gimby et al and Coxworth et al).

With respect to annual crops for off-farm sale, over 90% of this sector energy consumption is in the form of mobile liquid fuels for field operations and market delivery, and for chemical commodity crop service inputs (fertilizers and herbicides). Other farmstead contributions are of relatively minor importance and not considered in this review. Grain farms are straight forward as to the analyses, whereas for mixed farms, only those energy requirements attributed to such crops are included. Likewise, the solely ranching and dairy operations FEMP farms have been excluded. Averages quoted throughout subsequent sections should be regarded as representative indications as opposed to being drawn from a large statistical sampling. Nevertheless the FEMP farms exhibit a widely distributed range of managements under what might be termed conventional tillage practices.

6.2 Analytical Approach

Fundamentally, an overall farm cropping practice may be broadly defined as an aggregate of decision choices.

- specific crops or crop-mix selection
- cropping cycle rotation length, commonly marked by a fallow year
- level of investment in yield enhancement factors pertaining to moisture conservation (i.e. summerfallow, stubble snow trap innovations), fertility inputs (e.g. commercial fertilizers, legume plowdown, pulse crop inclusion in the rotation, and weed control measures (e.g. tillage, herbicides or combination thereof).

- availability of a machinery compliment compatible with crops and desired tillage-harvest systems (i.e. zero-till, minimum or conventional non-restricted tillage).

These somewhat inter-related factors, in effect determine the annual cropping energy commitment, and, together with local climate, the eventual productivity outcome.

Since the OPEC cartel policies of the early 1970's, general energy aspects, supply, end use efficiencies and pricing consequences have received much attention. Several comprehensive complex reports have been published some of which employ wide boundaries, including many less defined embodied energy items (e.g. capital machinery manufacture, attrition and maintenance; human labor, etc). Comparative performance is usually given as an energy output/input ratio (Warkentin, 1976; Southwell and Rothwell, 1977; Boerma et al, 1980; Jensen, 1977; Zentner et al, 1984). From an on-farm viewpoint, such treatments encounter a certain amount of difficulties in rationalizing some farm products into edible human energy values to attain ratio conclusions. A more simplified approach has been adopted for the FEMP farm analyses, as previously indicated, restricting the energy audit to cash commodity purchases relevant to specific crops in the total farm crop/fallow operations overview (Russell and Colwell, 1981).

Herein, the underlying concept is twofold. First, the energy committed to annual crops essentially defines the basic management system. One needs to recognize that a relatively large proportion is contributed prior to any determined harvest with its additional consumption (i.e. fallow year practices charged against subsequent crop, fertilizers and herbicides). Basic system energy input indicators are quantified in terms of mobile fuels (liters per hectare), total energy (fuels, fertilizers, herbicides, insecticides) and energy cost (dollars per hectare) according to the total cultivated area devoted to annual crops. Megajoule energy values have been adapted from the literature (see appendix 6D ; gasoline has been converted to diesel fuel equivalents on the basis of relative heat content factor 0.9 (many other studies incorporate an engine efficiency factor, using 0.75 for the conversion). Pricing reflects general 1983 farm service retail cost conditions.

Second, of most importance to individual farms is the crop productivity return for the energy and dollar expenditure. This is presented as productivity indices according to total cash crop tonnes, referred to mobile fuels (liters per tonne), total energy consumed (megajoules per tonne), and energy cost (dollars per tonne). Comparisons among farms is not strictly possible because of differing crop mix, with genetic inherent yield differences affecting the tonne total. For this reason, a wheat equivalent index has been introduced, whereby non-wheat crop production is adjusted upward (oilseeds) or downward (coarse grains) with the aid of Rural Municipality 10 year average yield ratios (Agricultural Statistics, 1982) for each farm. While this procedure is not entirely satisfactory, due to the wide spectrum of factors determining such average yields, it does make for a somewhat fairer comparison. In any event, the dominance of spring wheats in most rotations usually results in only minor alteration of the actual production productivity indices.

6.3 Annual Cropping Energy Consumption - 1983 FEMP Farm Survey

In part, the Farm Energy Management Program objectives included an on-farm evaluation of liquid fuel use distribution. Early assessments were made from estimates of purchase receipts, being replaced in 1982 by fuel tank metering and farm operator recording. The later procedure greatly improved the confidence of use sector identification; however, with respect to annual cropping, the broad categories precluded an analysis of any specific crop. Log sheet details were only sufficient to treat the matter in a general overview context. Such an overview for 1982 records is given here as rotation length averages for both straight grain and mixed farms across all soil zones. The more detailed individual farm analyses (not shown) did not show any soil zone location differences (note size of FEMP farm sample). A similar treatment for 1983 fuel records is not yet available, awaiting completion of purchase verification, reconciliation, and final collation.

The crop rotations of the FEMP farms roughly correspond to long established norms of their respective soil zone locations, that is, prevalence of 1/2:1/2 (Brown), 2/3:1/3 (Dark Brown) and more continuous cropping, including forages, in the varied soils of the Black zone (see appendices 6A and 6B). As anticipated, liquid fuel use increased in parallel to rotation length, or, in other words, the intensity of cropping (Table 2). Such an increase can be readily associated with additional field operations, harvested area, and grain handling of the same relative land base. Contrary to expectations, liquid fuel use variations were similar for all soil zones, management practices apparently overshadowing climate factors. Fuel liter productivity reveals a remarkable similar index value among locations, regardless of accepted presentation (i.e. actual crops or wheat equivalent format). The foregoing figures relate to the total annual cultivated acreage including both cropped and summerfallowed area. They can equally be presented on a cropped area basis by adjustment according

Table 2. Fuel use and length of crop rotation on FEMP farms

Nominal Rotation**	No. Farms in Class	Cropped Area% (1982)	Mobile Fuels* Consumption (L/ha d.f.e.)	Productivity Index (L/t) Actual Crops (1982)	Productivity Index (L/t) Wheat Equivalent (10 Yr. adjusted)
1/2:1/2	8	51	22.2	18.8	19.2
2/3:1/3	6	66	28.8	22.7	20.7
Extended (+80%)	4	90	42.2	22.9	21.8

*includes heavy truck cropping supports and market delivery.

**2/3:1/3 = 2/3 of land in crop, 1/3 of land in summerfallow.

to the appropriate rotation given.

Recognition of the fuel monitoring limitations for analysis of specific crops, plus a lack of a full appreciation for non-fuel energy commodity inputs, prompted an extensive FEMP farm survey. Detailed information for 1983 on field operations, fertilizer and herbicide applications, as carried out for given crops and summerfallow practices, was collected. Field fuel consumption for individual crops (or fallow) was estimated from a prepared unit operations schedule (liters per hectare according to job) adapted from the "Saskatchewan Agriculture Custom and Rental Rates 1982". In view of the multiple factors affecting field fuel consumption, the schedule values corresponded reasonably well to limited tests provided by some of the participating farms. The analysis resultant cumulative totals (specific crops plus fallow) corresponds, with respect to liquid fuels, to the previous type of overview presented for 1982 (see Appendix 6A for individual farm totals and rotation averages for 1983). The major difference in the treatment is that the survey data includes non-fuel fertilizer and herbicide totals (see Table 3). Individual farm analyses are on file, covering inputs to specific crops and summerfallow practices. Averaged inputs as to fallow or stubble situations (1983) for the more dominant crops are given in Appendix 6C. For fallow crops the current average farm summerfallow inputs are charged against this cropping position (used as an estimate of the legitimate previous years input). The argument here applied is that most of the benefits derived from fallowing are dissipated by this crop (i.e. moisture conserved, regenerated nutrients, certain weed controls). Notably, the semi-emperical fuel consumption determined, more or less collaborates

Table 3. Energy use distribution on FEMP farms in 1983

		Apparent Energy Consumption Per Cultivated Hectare								
					Fertilizers			Herbicides		
Cropped Area %	No. Farms	(L) Est.	Fuels (MJ)	($) (dfc)	(Kg)	(MJ)	($)	(Kg AcI)*	(MJ)	($)
50- 60	9	22.1	858	8	27.6	547	9	0.5	113	10
60- 70	5	23.7	919	9	69.2	1547	20	0.5	141	12
70-100	5	31.9	1235	12	103.3	2756	33	1.1	207	19

*kilograms active ingredient total.

the 1982 results with rotation averages within the 1982 indicated range. Completion of the 1983 fuel log data will allow a reconciliation of these estimates to the actual measured quantity alloted to annual cropping.

Summary highlights of the 1983 survey are given here according to cropped area percentage range (Table 4). This reference has been adopted because the survey indicated many former 1/2:1/2 rotation farms were experimenting with stubble cropping in a limited way, a departure from earlier years of the FEMP study (e.g. Brown soil zone farms). Elsewhere, rotations were noted to have been both expanded and contracted. Under the 50-60% rotations, energy consumption follows the ranking of fuels (∿57%), fertilizers (36%), herbicides (∿7%), whereas the extension to more stubble cropping reverses the order of fuels and fertilizers (due to the nitrogen requirement of stubble crops). Fertilizers then accounted for some 59 to 66%, with mobile fuels reduced to 35 and 29% respectively for the given rotation classification. Herbicides, due to their lower weight per area application compared to fertilizers, assume only a minor energy input role at about 5%. Economically, the 50-60% cropped area system distributes costs more or less uniformly among the three commodity categories, while the other types of rotations, with stubble crops, increase the relative proportions attributed to fertilizer (∿30%).

Extended rotations, as exemplified by the FEMP farm survey, doubles, to almost triples, the total energy consumption of annual crops. From a strictly energy conservation viewpoint, such a statement of fact is disturbing. However, more important is the productivity characteristics of such rotation systems. Averaged situations are tabulated here and shown

Table 4. Energy inputs and productivity indices for FEMP farms in 1983.

		Energy Inputs			Productivity Indices					
					Actual Crops (1983)			Wheat Equivalent		
Cropped Area %	Farms	Fuels (d.f.c.) (L/ha)	Total Energy (MJ/ha)	Energy Cost ($/ha)	Fuels (L/t)	Tot. Energy* (MJ/t)	Cost ($/t)	Fuels (L/t)	Tot. Energy* (MJ/t)	Cost ($/t)
50- 60	9	22.1	1515	26	18.5	1245	21	18.9	1262	22
60- 70	5	23.9	2611	41	19.9	2197	34	20.0	2204	34
70-100	5	31.9	4197	64	20.5	2611	40	19.2	2388	37

*Includes fuel, fertilizers and herbicides.

graphically (see Appendix 6B for individual farm details). Best demonstrated by the series of graphs, Figure 1-3, is the general increase in fuel, total energy consumed, and energy cost per hectare, for the various rotation classes, although there appears to be a certain degree of scatter amongst the systems. Most probably this arises from underlying land base fertility, cropping history, use of legume or forage acreage substitutes for commercial fertilizers, spectrum and seriousness of weed problems, in association with individual applied managements. Readily apparent is the lack of a discernable trend in liquid fuel use productivity. This was observed to be in the 12 to 22 litres per grain product tonne, with no apparent association to location. The upper figure was previously determined in the 1982 overview analyses. As mentioned earlier in sections, these treatment results apply to conventional tillage types of cropping systems. Interestingly, the tabulation averages for these systems shows similar energy productivity indices for rotations above 50-60% cropped area. Continuous cropping may be as yet too much in its infancy to substantiate this over the long term.

One zero tillage farm placed on the FEMP study in 1983 has been omitted as well from this review. Because of the radically different type of operation and lack of other farms in this class, no comments can be offered on the energy averages of such systems. This farm's performance rating is however included in the appendix summaries 6A, B and C. In addition, the same farm appears as #4, along with other non-FEMP farms, under the topic of winter wheat production, section 1.3.4. of Chapter 1.

Figure 1. Fuel use and productivity as affected by cropped area percentage.

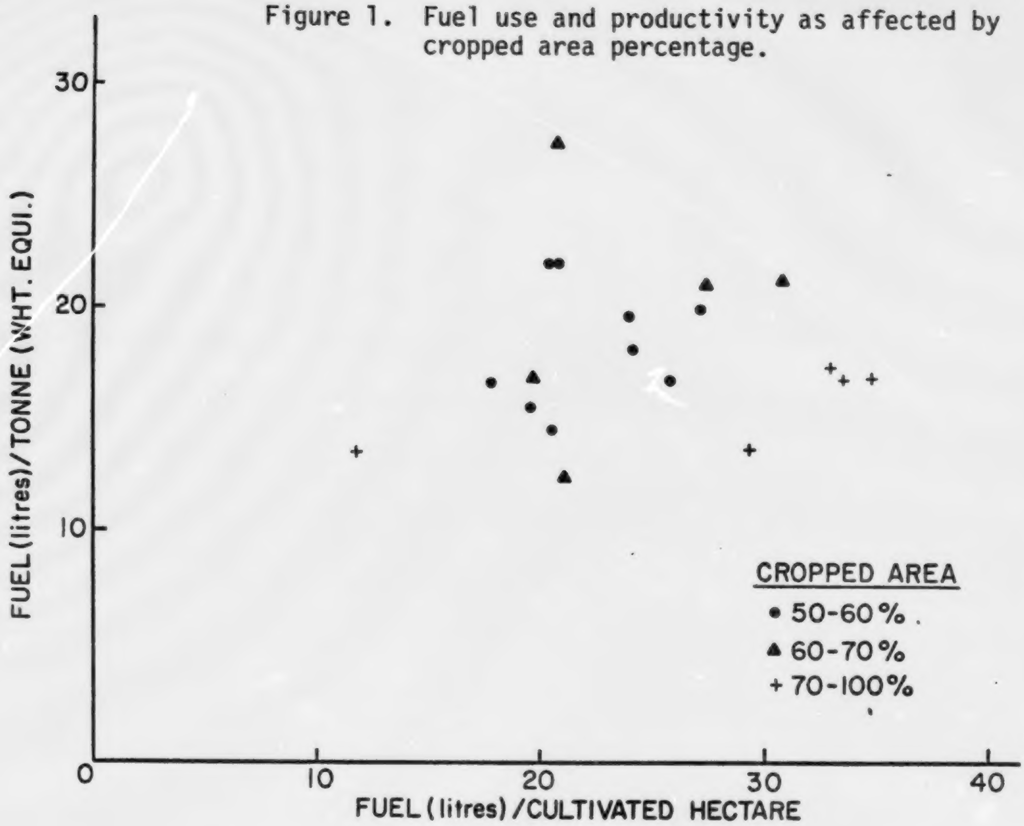


Figure 2. Total energy use as affected by cropped area percentage.

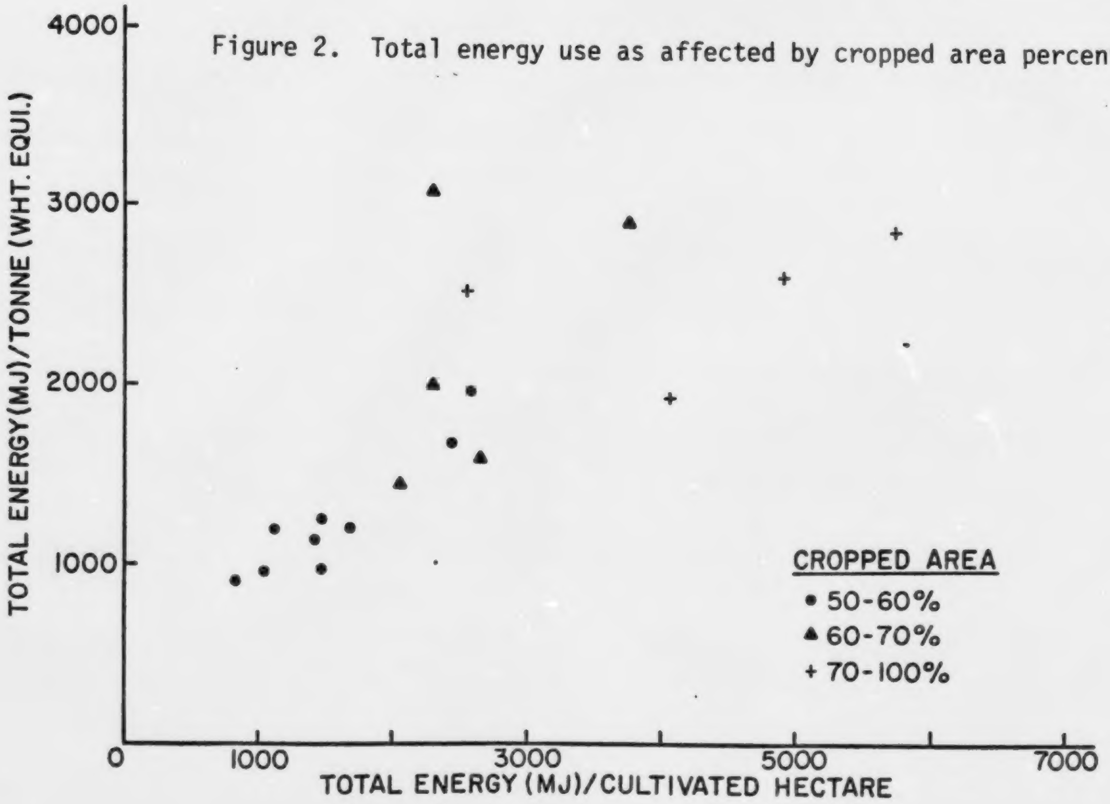
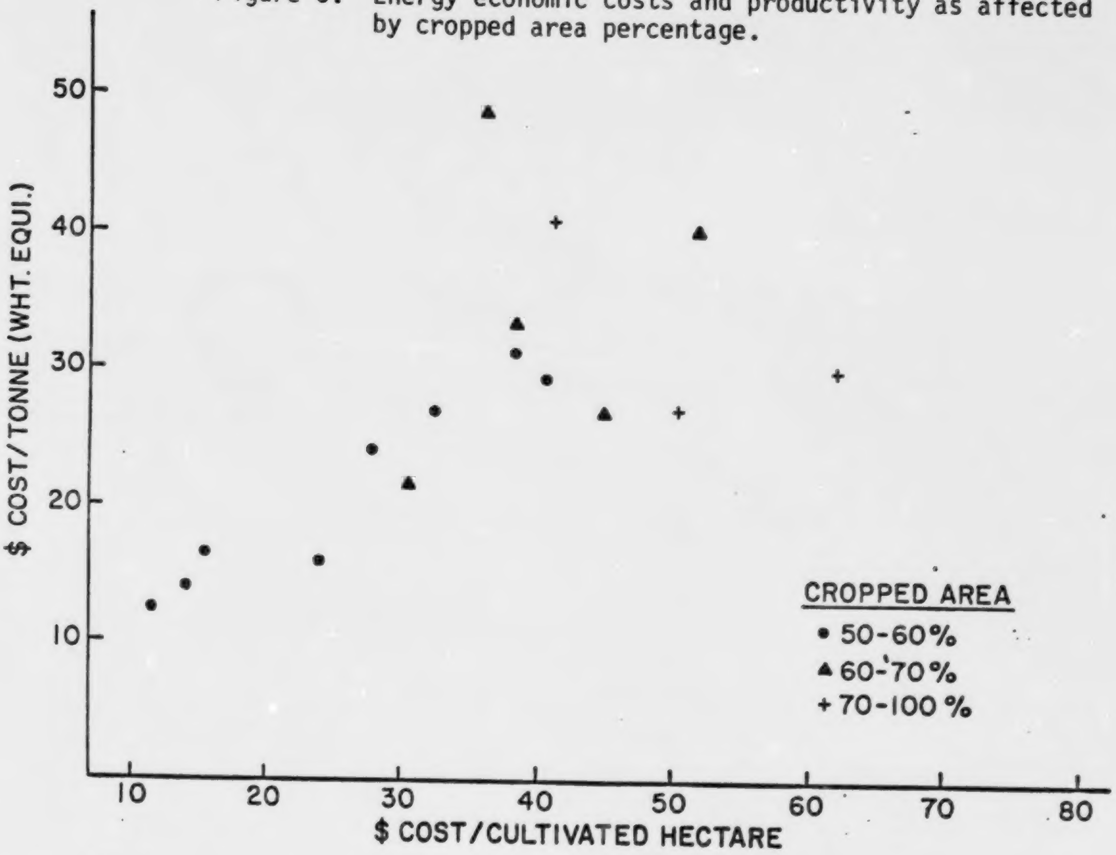


Figure 3. Energy economic costs and productivity as affected by cropped area percentage.



6.4 Summary Conclusions

The Farm Energy Management Program farms may be reasonably considered as representative of current widespread conventional tillage practices for annual crop production. Within the scope of the FEMP sample, unidentified factors obscure any soil zone location effects on average energy consumption. Major differences occur in the cropped area rotation length, primarily due to the large embodied energy related to the need for nitrogen fertilizer in extensive stubble cropping. Longer rotations are accompanied by increased liquid fuel use, total energy consumed, and related energy commodity costs. On the positive side, it would appear that liquid fuel requirements per grain product tonnes are independent of the rotation employed or farming location.

Central to the overall annual cropping energy consumption issue is the forms of energy trade-offs (i.e. liquid mobile fuels in demand for field operations as opposed to the large feed stock natural gas requirement for nitrogen fertilizer production). Alternately, the long known nitrogen fixation of legumes needs to be further examined. The latter is being now more throughly researched in less conventional innovative rotation. Hopefully some compromises can be attained.

6.5 References

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APPENDIX 6A

Summary of Apparent Energy Consumption in Annual Cropping (Cereals, Oilseeds, Contract Crops; 1983 data estimates).

				VARIABLE COMMODITY ENERGY INPUTS PER CULTIVATED HECTARE								
				Estimated Mobile Fuels			Fertilizers[4]			Herbicides/Insecticides[4]		
Nominal Cropped Area (%)	Soil Zone	Energy Project Farm Operation Type	No.	Qty. (L-dfe)	Energy (MJ)	Cost ($)	Qty. (kg)	Energy (MJ)	Cost ($)	Qty. (kg Acl)	Energy (MJ)	Cost ($)
50-60	Brown	Straight Grain	14	23.9	924.3	8.74	41.7	1012.2	14.70	0.56	107.8	9.21
			20	19.6	757.5	7.16	27.0	426.8	8.72	0.89	231.4	22.01
			18	20.4	790.2	7.47	29.9	613.1	10.62	1.10	271.8	22.59
			16	27.2	1050.7	9.94	20.1	285.5	7.02	0.54	138.2	10.90
	Dk. Brown	Mixed (Grain/Sheep)	9	17.6	699.1	6.61	42.1	344.7	6.71	0.01	4.5	0.70
	Black	Mixed (Grain/Hogs)	7	25.7	992.6	9.39	18.0	373.4	5.80	0.52	109.5	8.67
		(Grain/Beef)	12[1]	20.3	785.4	7.43	Nil	Nil	Nil	0.22	51.0	4.00
		(Grain/Mkt garden)	11*	20.6	796.1	7.53	22.4	318.3	7.82	Nil	Nil	Nil
		(Grain/Beef)	2*[1]	24.0	927.0	8.77	47.0	1548.1	17.21	0.48	103.4	8.24
				22.1	858.1	7.78	27.6	546.9	8.73	0.48	113.1	9.59
60-70	Brown	Mixed (Grain/Beef)	17	19.0	734.3	6.94	71.6	1424.5	18.33	0.29	113.4	12.98
	Dk. Brown	Straight Grain	5	21.0	812.4	7.68	80.6	1697.5	21.30	0.70	155.4	16.13
			15[2]	20.6	798.3	7.55	57.2	1332.1	18.45	0.56	173.2	10.44
		Mixed (Grain/Hogs)	13	27.3	1055.0	9.98	94.1	2519.8	28.79	0.74	161.2	13.36
	Black	Mixed (Grain/Dairy)	21	30.8	1192.8	11.28	42.6	759.7	13.69	0.41	102.6	5.52
				23.7	918.6	8.69	69.2	1546.7	20.11	0.54	141.2	11.69
70-100	Brown			--	--	--	--	--	--	--	--	--
	Dk. Brown	Straight Grain	3[1]	32.9	1271.6	12.03	71.9	2270.5	26.18	0.66	168.9	12.01
	Black	Straight Grain	23[3]	30.5	1179.0	11.15	70.5	1303.6	20.30	0.32	80.1	10.04
		Mixed (Grain/Beef)	6	32.4	1253.8	11.86	122.5	3282.2	35.90	2.90	380.9	34.49
		(Grain/Beef)	1*	29.2	1128.5	10.67	88.1	2733.6	33.28	0.83	205.9	18.25
		Straight Grain	8	34.7	1341.3	12.68	163.5	4188.5	49.71	0.65	198.2	19.48
				31.9	1234.8	11.68	103.3	2755.7	33.07	1.07	206.8	18.85
Zero-Till System												
100	Brown	Straight Grain	22	22.8	880.3	8.33	371.2	8633.0	80.49	0.65	219.9	38.28

* Figures given adjusted for hail damage as upgraded fuel useage.

[1] Cropping rotation altered from previous years (Farms 2 and 12 to approximate 50% from +80% and 67% respectively, Farm 3 to continuous crop from 67%: a number of Brown Soil Zone 50% cropping farms now including small acreages of stubble crops).

[2] Extreme drought reduced yields (Farm 15 - fallow rape and stubble barley less than 1/2 long term yields; Farm 22 - winter wheat).

[3] Approximate continuous cropping using partial fallow of fertilized oat-pea crop, seed costs not included.

[4] Various products and combinations of fertilizers and herbicides.

APPENDIX 6B

Summary of Overall Farm Annual Cropping Energy Characteristics (1983 data estimates)

				VARIABLE ENERGY INPUTS			PRODUCTIVITY INDICES					
							Actual Crops (1983)			Wheat Equivalent Adjusted[4]		
Nominal Cropped Area (%)	Soil Zone	Energy Project Farm Operation Type	No.	Mobile Fuels(dfe) (L/ha)	Total Energy (Fuel/Fert/Chem) (MJ/ha)	Energy Cost ($/ha)	Fuels (L/t)	Total Energy (MJ/t)	Cost ($/t)	Fuels (L/t)	Total Energy (MJ/t)	Cost ($/t)
50-60	Brown	Straight Grain	14	23.9	2044	32.65	19.5	1671	26.69	19.6	1683	26.88
			20	19.6	1416	37.89	15.2	1099	29.43	15.8	1144	30.62
			18	20.4	1675	40.68	14.7	1208	29.35	14.8	1211	29.41
			16	27.2	1474	27.86	21.7	1179	22.27	23.2	1262	23.85
	Dk. Brown	Mixed (Grain/Sheep)	9	17.6	1024	14.02	16.5	960	13.83	16.9	986	14.20
	Black	Mixed (Grain/Hogs)	7	25.7	1476	23.86	16.4	944	15.26	17.0	981	15.85
		(Grain/Beef)	12[1]	20.3	836	11.43	21.8	900	12.30	22.2	916	12.52
		(Grain/Mkt Garden)	11*	20.6	1114	15.35	22.2	1205	16.60	22.2	1205	16.60
		(Grain/Beef)	2[1]	24.0	2579	27.01	18.9	2035	27.01	18.3	1974	26.20
				22.1	1515	25.64	18.5	1245	21.42	18.9	1262	21.79
60-70	Brown	Mixed (Grain/Beef)	17	19.6	2294	38.49	16.5	1928	32.30	17.1	2002	33.54
	Dk. Brown	Straight Grain	5	21.0	2665	45.11	13.6	1724	29.18	12.6	1597	27.03
			15[2]	20.6	2304	36.44	29.3	3274	51.79	27.6	3081	48.73
		Mixed (Grain/Hogs)	13	27.3	3736	52.13	19.6	2679	37.38	21.2	2896	40.41
	Black	Mixed (Grain/Dairy)	21	30.8	2055	30.49	20.7	1381	20.49	21.6	1442	21.39
				23.9	2611	40.53	19.9	2197	34.23	20.0	2204	34.22
70-100	Brown		--	--	--	--	--	--	--	--	--	--
	Dk. Brown	Straight Grain	3[1]	32.9	3711	50.22	19.8	2237	30.27	17.6	1992	26.96
	Black	Straight Grain	23[3]	30.5	2563	41.49	27.8	2336	37.83	30.1	2530	40.97
		Mixed (Grain/Beef)	6	32.4	4917	82.25	20.7	3143	52.57	17.2	2612	43.69
		(Grain/Beef)	1*	29.2	4068	62.20	13.6	1898	29.02	14.0	1960	29.97
		Straight Grain	8	34.7	5728	81.87	20.8	3441	49.19	17.2	2846	40.68
				31.9	4197	63.61	20.5	2611	39.78	19.2	2338	36.45
Zero-Till System												
100	Brown	Straight Grain	22[2]	22.8	9734	127.10	11.6	4970	64.90	13.9	5964	77.88

* Figures given adjusted for hail damage

[1] Cropping rotation altered from previous years (Farms 2 and 12 to approximately 50% from +80% and 67% respectively; Farm 3 to continuous crop from 67%: a number of Brown Soil zone 50% cropping farms now including small acreages of stubble crops)

[2] Extreme drought reduced yields (Farm 15 - fallow rape and stubble barley less than 1/2 long term yields; Farm 22 - winter wheat affected)

[3] Approximate continuous cropping using partial fallow of fertilized oat-pea crop, seed costs not included.

[4] Wheat equivalent adjustment on basis of Rural Municipality current 10-year average yields - spring wheat to non-wheat crop ratio (Agricultural Statistics, 1982).

APPENDIX 6C

Specific Crop Apparent Energy Characteristics (Traditional Tillage Farms - 1983 crop data)

Crop Grown	Rotation Position	Soil Zone	Project Farm No.	Gross Yield	Est. Net Value	VARIABLE ENERGY INPUTS Mobile Fuels(dfc)	Total Energy (Fuel/Fert/Chem)	Energy Cost	PRODUCTIVITY INDICES 1983 Crop Fuels	Total Energy	Cost
				(kg/ha)	($/ha)	(L/ha)	(MJ/ha)	($/ha)	(L/t)	(MJ/t)	($/t)
Sp. Wheats	Fallow	Brown	14	2017	318.17	46.8	2602.2	45.70	24.2	1346.2	23.64
			17	1821	286.08	36.0	2260.4	54.44	20.7	1301.3	31.34
			20	2693	429.70	39.0	2621.9	76.71	15.0	1004.9	29.40
			18	2656	423.61	39.5	2676.3	72.61	15.4	1040.6	28.23
			16	2219	353.45	53.4	2881.8	55.75	24.9	1342.9	25.98
				2281	362.24	42.9	2608.5	61.04	20.0	1207.2	27.72
		Dk. Brown	5	2354	371.07	36.8	2394.2	55.01	16.3	1062.7	24.42
			15	1504	233.87	35.3	2094.2	33.43	24.9	1474.8	23.54
			13	2188	360.37	49.4	4499.2	89.93	23.5	2168.2	43.07
			3	2017	318.37	43.8	2371.8	36.02	22.7	1227.0	18.63
			9	2354	371.07	32.9	1846.2	28.02	14.6	819.4	12.44
				2083	330.95	39.6	2641.1	48.48	20.4	1350.4	24.42
		Black	2	2448	388.20	44.7	2530.2	51.54	19.0	1073.5	21.87
			7	2858	456.88	49.2	2502.1	42.95	17.7	902.0	15.48
			12	2017	315.75	40.4	1697.9	26.93	21.1	885.7	14.05
			21	2522	401.54	60.2	3320.7	53.12	24.7	1362.0	21.79
			11*	1855	288.88	41.0	2187.1	29.80	23.4	1246.9	16.99
				2340	370.25	47.1	2447.6	40.87	21.2	1094.0	18.04
Sp. Wheats	Stubble	Brown	14	2017	318.37	28.7	5226.3	75.01	14.8	2703.7	38.80
			17	2159	341.75	23.9	6278.9	80.49	11.5	3026.0	38.79
			18	2468	395.45	27.8	6366.2	101.61	11.6	2651.5	42.32
				2215	351.86	26.8	5957.1	85.70	12.6	5587.5	39.97
		Dk. Brown	5	2354	372.88	24.4	5575.8	61.36	10.8	2474.8	27.23
			15	1388	214.28	24.1	4535.4	53.74	18.5	2486.1	41.31
			3	2017	318.37	39.7	4619.5	56.53	20.5	2389.8	29.25
			9	897	133.90	19.2	1495.6	17.93	23.6	1839.6	35.46
				1664	259.86	26.9	4056.6	47.39	18.4	2547.6	33.31

APPENDIX 6C (continued)

Specific Crop Apparent Energy Characteristics (Traditional Tillage Farms - 1983 crop data)

Crop Grown	Rotation Position	Soil Zone	Project Farm No.	Gross Yield	Est. Net Value	VARIABLE ENERGY INPUTS Mobile Fuels(dfc)	Total Energy (Fuel/Fert/Chem)	Energy Cost	PRODUCTIVITY INDICES 1983 Crop Fuels	Total Energy	Cost
				(kg/ha)	($/ha)	(L/ha)	(MJ/ha)	($/ha)	(L/t)	(MJ/t)	($/t)
		Black	2*	2825	450.29	29.2	4891.3	70.60	10.7	1789.1	25.82
			23	1870	291.35	30.3	3495.7	76.67	17.1	1976.1	43.34
			7	2354	373.87	36.5	5668.9	75.78	16.1	2497.3	33.38
			12	1009	152.35	26.8	1106.2	12.47	29.0	1195.9	13.48
			21	2017	318.37	29.1	3569.9	42.30	15.0	1846.8	21.88
			6	2286	362.67	33.9	6424.8	95.36	15.4	2917.7	43.31
			1*	2555	409.77	27.6	4929.8	73.05	11.1	1981.4	29.36
			8	2219	348.34	35.3	6464.6	79.73	16.7	3056.6	37.70
				2142	338.38	31.1	4568.9	65.75	16.4	2157.6	31.03
Zero-Till System											
Sp. Wheat	Stubble	Brown	22	2690	429.21	24.9	10016.8	157.88	9.6	3843.8	60.58
Barley	Fallow	Brown	17	2152	286.02	36.3	2201.4	41.36	17.4	1055.8	19.84
			20	2668	351.32	40.1	2690.4	71.96	15.7	1050.5	28.10
			18	4304	580.41	43.6	2836.0	74.12	10.3	670.3	17.52
			16	3174	426.22	56.0	2945.6	52.99	18.0	948.1	17.06
				3075	410.99	44.0	2668.4	60.11	15.4	931.2	20.63
		Dk. Brown	3	2152	286.17	44.8	2410.9	36.39	21.6	1164.1	17.57
		Black	7	3389	455.71	51.0	2176.4	33.85	15.4	655.1	10.19
			12	2959	396.72	43.9	1807.1	23.81	15.2	624.9	8.23
				3174	426.22	47.5	1991.8	28.83	15.3	640.0	9.21
Barley	Stubble	Brown	14	2260	298.92	28.8	4824.7	44.61	13.2	2214.2	20.47
			20	2152	280.40	25.4	4982.2	63.30	12.4	2437.5	30.97
				2206	289.66	27.1	4903.5	53.96	12.8	2325.9	25.72
		Dk. Brown	15	912	115.92	23.7	3962.1	47.79	28.0	4688.9	56.56
			13	2347	313.01	31.2	6334.0	64.93	14.1	2850.5	28.93
			3	1614	210.30	28.9	3918.7	47.63	18.9	2556.2	31.07
			9	2152	286.02	21.4	1688.4	20.28	10.3	809.8	15.70
				1756	231.31	26.3	3975.8	45.23	17.8	2726.4	33.07

APPENDIX 6C (continued)

Specific Crop Apparent Energy Characteristics (Traditional Tillage Farms - 1983 crop data)

						VARIABLE ENERGY INPUTS			PRODUCTIVITY INDICES		
									1983 Crop		
Crop Grown	Rotation Position	Soil Zone	Project Farm No.	Gross Yield	Est. Net Value	Mobile Fuels(dfc)	Total Energy (Fuel/Fert/Chem)	Energy Cost	Fuels	Total Energy	Cost
				(kg/ha)	($/ha)	(L/ha)	(MJ/ha)	($/ha)	(L/t)	(MJ/t)	($/t)
Barley	Stubble	Black	2*	2329	305.77	32.5	5551.2	64.44	14.6	2490.4	28.91
			23	2260	298.92	33.0	3424.2	43.17	15.1	1571.5	19.81
			21	2044	270.66	30.8	2491.7	34.07	15.6	1262.9	17.27
			6	2285	302.33	37.8	7505.5	96.51	17.2	3425.4	43.97
			1	3228	435.41	29.8	4943.2	59.82	9.4	1557.4	18.85
			8	2152	280.40	31.4	6312.2	78.29	15.4	3088.2	38.30
				2383	315.58	32.6	5038.0	62.72	14.6	2232.6	27.85
Canola	Fallow	Brown		--	--	--	--	--	--	--	--
		Dk. Brown	15+	307	102.94	37.1	3235.5	68.34	123.3	10749.2	227.04
			13	1618	573.50	49.9	3252.9	72.06	29.8	1939.7	42.97
						43.5	3244.2	70.2			
		Black	2	1401	477.75	43.4	2426.0	47.78	31.1	1736.6	34.20
			6	1513	515.36	52.0	4040.1	95.36	34.5	2680.9	63.28
			1*	1401	477.06	61.3	3833.9	83.67	43.9	2748.3	59.98
			8	1849	630.95	58.0	5627.8	94.44	31.4	3050.3	51.19
				1541	525.28	53.7	3982.0	80.31	35.2	2554.0	52.16
Canola	Stubble	Brown		--	--	--	--	--	--	--	--
		Dk. Brown		--	--	--	--	--	--	--	--
		Black	6	1289	438.76	38.0	4204.7	104.61	29.6	3277.2	81.54
			1	1401	477.06	26.8	5264.6	94.44	19.2	3773.9	67.70
			8	1569	534.86	38.8	6804.8	98.01	24.8	4350.9	62.67
				1420	483.56	34.5	5424.7	99.02	24.5	3800.7	70.64
Fallow Practice		Brown	14	regular tillage		11.7	453.3	4.29			
				(tillage-chemical)		(12.6)	(784.9)	(25.17)			
			17	regular tillage		13.8	532.4	5.04			
				(chemical)		(4.2)	(1294.0)	(113.16)			
			20	regular tillage		13.8	532.5	5.04			
			18	regular tillage		13.8	532.5	5.04			
			16	regular tillage		20.9	807.7	7.64			
				regular tillage		14.8	571.7	5.41			

APPENDIX 6C (continued)

Specific Crop Apparent Energy Characteristics (Traditional Tillage Farms - 1983 crop data)

Crop Grown	Rotation Position	Soil Zone	Project Farm No.	Gross Yield	Est. Net Value	VARIABLE ENERGY INPUTS			PRODUCTIVITY INDICES		
									1983 Crop		
						Mobile Fuels(dfc)	Total Energy (Fuel/Fert/Chem)	Energy/ Cost	Fuels	Total Energy	Cost
				(kg/ha)	($/ha)	(L/ha)	(MJ/ha)	($/ha)	(L/t)	(MJ/t)	($/t)
Fallow Practice		Dk. Brown	5	regular tillage		14.1	544.5	5.15			
			15	regular tillage		15.0	580.1	5.49			
			13	regular tillage		19.7	761.6	7.20			
			9	regular tillage		18.3	708.2	6.70			
				(partial fallow)		(8.7)	(336.7)	(3.18)			
				regular tillage		16.8	648.6	6.14			
		Black	2	regular tillage		17.3	668.0	6.32			
			23	(oat-pea plowdown)		(29.0)	(1122.2)	(10.61)			
			7	regular tillage		21.0	813.1	7.69			
				(clover plowdown)		(25.4)	(984.2)	(9.31)			
			12	regular tillage		14.2	548.8	5.19			
				(clover plowdown)		(17.3)	(668.8)	(6.33)			
				(partial fallow)		(12.6)	(488.9)	(4.62)			
			21	regular tillage		18.6	719.8	6.81			
			6	regular tillage		26.1	1008.8	9.54			
				(partial fallow)		(15.6)	(602.9)	(5.70)			
			1	regular tillage		37.0	1431.1	13.53			
			11	regular tillage		18.5	714.0	6.75			
			8	regular tillage		22.9	886.6	8.39			
				regular tillage		22.0	848.8	8.03			
				(partial plowdowns)		(20.0)	(773.4)	(7.31)			

---

* Figures adjusted for hail damage

† Extreme draught reduced fallow canola yield, not included in averages.

APPENDIX 6D ENERGY CONVERSION FACTORS

ENERGY INPUT COMMODITY		ENERGY CONTENT	REFERENCE
A. DIRECT ENERGY			
Diesel fuel		38.7 MJ/L	(1)
Motor gasoline		34.7 MJ/L	(1)
Light fuel oil		38.7 MJ/L	(1)
Propane		25.6 MJ/L	(2)
Natural gas		37.2 MJ/m^3	(1)
Wood (oven-dried)		20.0 MJ/kg	(3)
Electricity		3.6 MJ/Kwh	(1)
B. EMBODIED ENERGY			
i) FERTILIZERS		MJ/Kg	
Anhydrous ammonia	(82-0-0)	47.3	(2)
Urea	(46-0-0)	32.7	(2)
Ammonium nitrate	(34-0-0)	23.8	(2)
Aqueous ammonia	(20-0-0)	11.8	(2)
Mono ammonium phosphate	(11-48-0)		
	(11-51-0)	14.2	(2)
	(11-55-0)		
Ammonium nitrate phosphate	(23-23-0)	19.2	(2)
	(25-25-0)	21.5	(2)
	(27-27-0)	25.0	(2)
	(34-17-0)	26.0	(2)
ii) HERBICIDES, INSECTICIDES, FUNGICIDES		MJ/kg Active Ingredient	
Aldrin			(5)
Avadex (trillate)	G	231	(5)
Avenge	WS	228	(4)
Banuel LH (dicamba)	S	402	(4)
Buctril M (bromoxnil/WS MCPA)		295	(5)
Carbyne		228	(5)
Cygon		211	(5)

APPENDIX (cont'd) ENERGY CONVERSION FACTORS

HERBICIDES, INSECTICIDES, FUNGICIDES	MJ/kg Active Ingredient	REFERENCE
Dyvel (dicamba/MCPA)	184	(4)
Dieldrin	211	(5)
Esteron 99	228	(5)
Furadan G	219	(4)
Gammasan WP	141	(5)
Glean WP	265	(4)
Heritage G	375	(5)
Hoegrass (propanil)	328	(5)
Mataven EC	461	(4)
Malathion EC	385	(5)
MCPA WS	129	(5)
Pardner EC	461	(4)
Poast EC	461	(4)
Roundup (glyphosate)	387	(4)
Sabre (bromoxnil/WS MCPA)	295	(5)
Sencor WS	228	(4)
Stampede (propanil)	328	(5)
Stampede (propanil/MCPA)	285	(4)
Sweep (paraquat)	415	(4)
Treflan (trifluralin) EC	375	(5)
Torch EC	461	(4)
2,4-D Amine WS	82	(5)
2,4-D Ester EC	202	(5)
Weed No More 80	228	(5)

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5 ANALYSIS OF ENERGY USE

5.1 INTRODUCTION

The basic objective of the Farm Energy Management Program was to analyse energy use on each individual farm in the program and to identify where energy use can be reduced or energy can be used more productively.

Since the farms in the program varied widely in aspects such as size, type of enterprise, climate and soil conditions, number and age distribution of people living on the farm, distance to town, et cetera, the energy use of each farm was not directly comparable to that of others.

Nevertheless, summary tables showing comparative results for all 23 farms involved in the program were useful for identifying general trends, differences, apparent anomalies requiring further investigation, and the relative importance of the various energy inputs.

The farm energy inputs studied in the Farm Energy Management Program consist of four categories:

1 Liquid fuels (diesel fuel and gasoline), used in mobile production and transportation equipment;
2-a Heating fuels (heating oil, propane, natural gas, wood and some electricity), used for space and water heating in homes, shops and livestock buildings and for grain drying;
2-b Electricity (except the portion used for space and water heating), used in homes for lights and appliances; outside for yard lights, blockheaters, watering bowls and grain dryer fans; in shops for lights, welders and small motors; and in livestock buildings for fans and grinding feed;
3 Plant nutrients (nitrogen and phosphate fertilizers);
4 Herbicides.

The quantities of these inputs purchased in 1980, 1981, 1982 and 1983 (herbicides for 1983 only) were obtained from the cooperators' records. (Wood, used on a few farms, was obtained locally at zero out-of-pocket cost.) More detailed records of the use of electricity and natural gas on the cooperators' farms were obtained from the Saskatchewan Power Corporation.

A breakdown of the liquid fuels used on the cooperators' farms in 1982 and 1983 by equipment and type of operation was obtained through a fuel metering program, involving the installation of dispensing meters on all fuel storage tanks, including portable tanks, and the keeping of fuel dispensing logs for each meter by the cooperators.

We will discuss each of the four energy input categories separately.

5.2 LIQUID FUELS

5.2.1 Methods

Evaluation and Installation of Fuel Meters

Fuel dispensing meters were installed on all farm fuel tanks for measuring the volumes of fuel used by production equipment and vehicles. Three sizes of meters were required:

Size	Number
0.75" (19 mm)	78
1.50" (38 mm)	3
2.00" (51 mm)	1

Two makes of 19 mm meters, Gasboy and Fillrite, were evaluated for possible use in the program. Tests conducted by D. Olm (SRC) showed both meters to perform equally well in terms of measuring a given volume of liquid. The Fillrite was selected because its dispensing register would display a maximum of 999 L, whereas the Gasboy meter would display only 99 L, which was less than many cooperators would require when fuelling their tractors. For the three cooperators requiring 38 mm meters, the Gasboy meter was chosen because of availability and service. A used 51 mm meter was acquired for the one farm requiring this size.

The meters were installed in April 1982, either by the cooperators or, in a few cases, by the FEMP research team. The meters were installed both on the stationery fuel tanks in the farm yards and on the slip tanks carried in pickup trucks for refuelling equipment in the fields. Aluminum clipboards, complete with aluminum covers, for holding log sheets were installed near each meter. The log sheets (p. 5.3) were printed on waterproof paper. A pencil and sharpener were attached to each clipboard.

In nearly all cases, the cooperators accepted the concept of keeping track of their fuel use with considerable interest. Initially, some expressed concern about the time that would be required to fill out the logs, but this never became a problem.

Some examples of a positive response from the cooperators include:

- All of the cooperators indicated that the meters gave them a better idea of where their fuel was used and how much different operations required.

- A few of the cooperators mentioned that they were attempting to use the meters as a conservation tool by measuring fuel use before and after a change in field operations (such as cultivating deeper or changing gears and throttle setting).

- One cooperator with two identical tractors and implements was

FUEL LOG SHEET

FARM ____________________

FUEL TANK ____________________

DATE	VEHICLE or MACHINE	HOURS or mi or km	Litres	Accumulated Litres	Jobs Done Last Tank		General Comments
					Job	Hrs or km	

using the meters to see which of his operators could get the best fuel economy (he offered a bonus incentive to the winner!).

Some problems were encountered:

- In a few cases the meters failed to function properly and had to be repaired or replaced.

- A few cooperators complained that the meters reduced the fuel flow rate, thus increasing fuelling time. They found this particularly bothersome during the busy season.

- According to factory specifications, a flow rate greater than 18 L/min (4 gpm) is required for the Fillrite meter to measure fuel flow accurately. In some cases, where the storage tank elevations were very low, the flow rate was less than 18 L/min and the meters would not function properly. For the 1983 season, cooperators having this problem either raised their tanks, used pumps, or used a larger hose and nozzle.

Data Collection

The farm fuel metering part of the FEMP involved measuring and recording the volumes of liquid fuel (diesel fuel and gasoline) used by each piece of production and transportation equipment for specific operations. Record keeping started at the end of April 1982 and was continued to the end of 1983.

The hardware which enabled the cooperator to do this has been described above. In summary, it consisted of:

- A dispensing dual-register fuel meter on each stationery farm fuel storage tank and on each slip tank used for refuelling in the field. One register was reset to zero at the start of each equipment fuelling operation and registerd the volume of fuel added to the on-board tank. The other register accumulated the total volume of fuel dispensed from the storage or slip tank.

- A log sheet at each fuel storage and slip tank.

- An on-board use meter (hour meter; odometer) with a register showing the accumulated use of the equipment in hours, kilometers or miles.

At each fuelling operation, the cooperator recorded on the log sheet the following set of data: day; month; equipment identification; use meter (register) reading; volume of fuel added to the on-board tank; accumulated fuel dispensed from the tank; and the operation(s) for which the equipment was used since its on-board tank was filled last. This set of data is referred to as a "record". The records were analysed by calendar year.

The farm fuel (diesel fuel and gasoline) metering program, started with 21 farms in April 1982 and was continued during 1983. Farm 4 dropped out of the program during 1982, and Farms 22 and 23 were added during 1983. Farm 8 supplied no fuel log records for 1983.

The log sheets of 20 farms for the period May to December 1982 yielded a total of 5800 records. The log sheets of 21 farms for the calendar year 1983 yielded 7000 records.

In general, the fuel log records kept by the cooperators in 1983 were of a quality similar to or better than that of the 1982 records. Several cooperators asked for copies of the log sheets for their own use. Both the improved quality of the logs and the use of the logs by the cooperators are indications of their interest in the program.

Although some of the log sheets for Farms 1 and 3 were lost when wind storms ripped them from their clip boards, and some logsheets for Farm 21 disappeared mysteriously from the farm, most of the lost data could be reconstructed from back-up records kept by the cooperators or by other means.

Data Standardization and Storage

The completed log sheets were marked up by the project team with brief codes indicating the group of operations performed (p. 5.6).

The records were then entered in a computer file. Considerable effort was required to standardize these records for computer analysis.

Apart from the inevitable errors made during data entry, the following problems were encountered with the data as found on the log sheets:

- identification of the same piece of equipment by different names;
- operations for which equipment was used recorded only some of the time;
- use meter readings recorded only some of the time;
- a small number of simple mistakes (obviously wrong date or use meter reading).

The first two of these problems were resolved through consultation with the cooperator.

The third problem was resolved for some pieces of equipment by interpolating missing use meter readings where this was judged to be appropriate. For other pieces of equipment not enough use meter readings were available to provide any meaningful results and all such readings were set to zero.

The fourth problem was corrected by changing obviously erroneous records so as to eliminate inconsistencies.

Fuel Log

Operations Categories

CROP:

S: CROP PRODUCTION (earlier called SEEDING): Includes seedbed preparation, fertilizer application, hauling of seed and fertilizer, and seeding.

SWC: SUMMERFALLOW & WEED CONTROL: Includes summerfallow (cultivate, rodweed, et cetera), spraying and water hauling for spraying, and Avadex and Treflan application. (Where Avadex was applied during seeding and was difficult to separate, it was included in CROP PRODUCTION).

H: HARVEST & HAULING: Includes swathing, combining, augering, hauling, drying and storage.

LI: LAND IMPROVEMENT: Rock and root picking, bush clearing, draining, filling wash-outs, et cetera.

FS: FARMSTEAD: Mowing, painting, pressure washing, gardening, et cetera.

CM: CROP MISCELLANEOUS: Operations that don't fit under any of the above categories, such as flax straw burning.

VEHICLES:

T: TRANSPORTATION: All uses of cars and light trucks (< 1 ton) unless it was indicated they were used for hauling grain, feed or other loads other than people.

LIVESTOCK:

F: FEED: Cutting, conditioning, baling, ensiling, hauling, and feeding.

M: MANURE: Manure handling.

LM: LIVESTOCK MISCELLANEOUS: Operations which do not fit under FEED or MANURE handling, such as pounding posts.

OTHER ITEMS:

R: RECREATION: Boat or skidoo.

C: CUSTOM: Where the farmer did custom work for someone else.

An example of how the records are stored in the computer's Fuel Log file follows:

1	2	3	4	5	6	7	8
05/11/82	1	d	8440	1174	1176	swc	319
06/05/82	1	d	case	0	0	m	65

where: column 1 contains: date (day/month/year)
column 2 contains: farm number
column 3 contains: fuel type (d= diesel fuel)
column 4 contains: equipment identification code (see next text table)
column 5 contains: use meter (hour meter; odometer) reading at previous fuelling operation (0 = "no reading")
column 6 contains: use meter reading at time of fuelling
column 7 contains: operation performed last (see Table 5.1 for explanation of code)
column 8 contains: volume of fuel taken on (litres)

Three other computer files were created: an Equipment Identification file; an Operations file; and a Fuel Type file.

The Equipment Identification file contains brief equipment descriptions for each of the equipment identification codes used in the Fuel Log record file, as well as the unit of its use meter register (h = hour; km = kilometre; mi = mile). An example of records stored in the Equipment Identification file is:

1	2	3	4
1	8440	Tractor, JD 8440, 1980	h
1	case	Skidsteer loader, Case 18	h

where: column 1 contains: farm number
column 2 contains: equipment identification code
column 3 contains: equipment description
column 4 contains: use meter unit

The Operations file contains short descriptions of each of the operations codes used in the Fuel Log record file, such as:

1	2
swc	Summerfallow and weed control
s	Crop production

where: column 1 contains: operations code
column 2 contains: short description of group of operations

The detailed description of the groups of operations is shown on page 5.6.

The Fuel Type file contains only two records:

1	2
d	Diesel fuel
g	Gasoline

The system of computer files described above provides a flexible data base which makes it easy to add, delete or change fuel log records, equipment, equipment descriptions, operations, operations descriptions and alternative fuels.

Data Manipulation and Report Creation

Computer programs were written by L. Reid (SRC) to manipulate the fuel log record data and to create a number of reports. Sample reports, referred to below, are provided in the Appendices to this report.

First, the records were sorted by farm number, by fuel type, by equipment, by operation and by date, to create the Farm Fuel Log Detail Report (for sample of report see: Appendix A, A-2 to A-12). The report is preceded by a Farm Fuel Log Legend (Appendix A, A-1), explaining the abbreviations used. The Farm Fuel Log Detail Report also shows the fuel use rate (in litres per hour (L/h) and Imperial gallons per hour (gph)) for farm production equipment and the fuel use rate (in litres per one hundred kilometers (L/100 km), kilometers per litre (km/L) and miles per Imperial gallon (mpg)) for vehicles. The Farm Fuel Log Detail Report is particularly useful in spotting problems with the record keeping, such as lapses in recording fuellings, off-farm fuellings, inconsistent recording of use meter readings, et cetera.

The average fuel use rate (in L/h or L/100 km) computed for farm production equipment and vehicles, respectively, by operation, and for all operations combined was calculated after eliminating records for which the use meter readings were zero and after adjusting obviously erroneous records.

To provide an overview of the results presented in the Farm Fuel Log Detail Report for each farm, they were summarized in the following computer-generated tables: Liquid Fuel Use by Equipment, 19xx (for sample of report see: Appendix B); Liquid Fuel Use by Operation, 19xx (Appendix C); Use of Diesel Fuel by 10-day Period, 19xx (Appendix D); Use of Gasoline by 10-day Period (Appendix E); and Equipment Fuel Use by Month, 19xx (Appendix F).

When the Year II Report was published in March 1983, we had just completed the preliminary processing of the fuel log data for the period May-December, 1982. To arrive at fuel use profiles for the calendar year 1982, these preliminary results were adjusted for obvious lapses in recording fuellings, off-farm fuellings, and estimated fuel use in the period January-April, 1982. For 1983, logs were available for the full calendar year but adjustments still had to be made for lapses in recording and for off-farm fuellings. A few vehicles for which only the total annual fuel use was available were entered as one record dated 31 December.

The total diesel fuel and gasoline for each farm so estimated (referred to as "metered" fuel) was then compared with the quantities of fuels reported by the cooperators as purchased during the year.

Where there were large discrepancies between the quantities of metered and purchased fuel, further consultations were held with the cooperators. In several cases this brought to light very substantial quantities of fuel used which had not been reported previously. The metered quantities were then adjusted accordingly. Diesel fuel use on Farm 7 in 1982 was adjusted for a suspected meter error which was confirmed in 1983. A visual comparison between the so-adjusted metered and purchased quantities is provided in Figures 5.1a (5.1b) and 5.2a (5.2b).*

Any remaining differences between the metered and purchased quantities are the result of changes in inventory between the beginning and end of the year, meter errors and reporting errors.

In general, we feel the metered quantities adequately describe liquid fuel use on the cooperators' farms, with the exception of the 1982 metered quantities for Farm 13, which appear to be substantially less than the actual fuel used.

5.2.2 Results

Liquid Fuel Use by Equipment

Table 5.1a (5.1b) shows the use of diesel fuel and gasoline on 20 (21) farms in 1982 (1983) by equipment type. The distribution of fuel use among the various equipment categories varies greatly among individual farms. However, for the aggregate of 20 (21) farms some general observations can be made.

- The tractors were almost exclusively powered by diesel fuel.

- Where self-propelled swathers and combines were used, the former without exception ran on gasoline while half of the latter ran on diesel fuel.

- On most farms heavy trucks ran on gasoline. Two very large farms had diesel-powered heavy trucks for hauling product. One of the dairy farms had a diesel-powered truck for hauling hay.

- Virtually all the cars and light trucks ran on gasoline.

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* Where two references are shown (such as Figure 5.1a (5.1b)), the reference outside the parentheses is to results for 1982, the reference inside the parentheses is to results for 1983.

Figure 5.1a

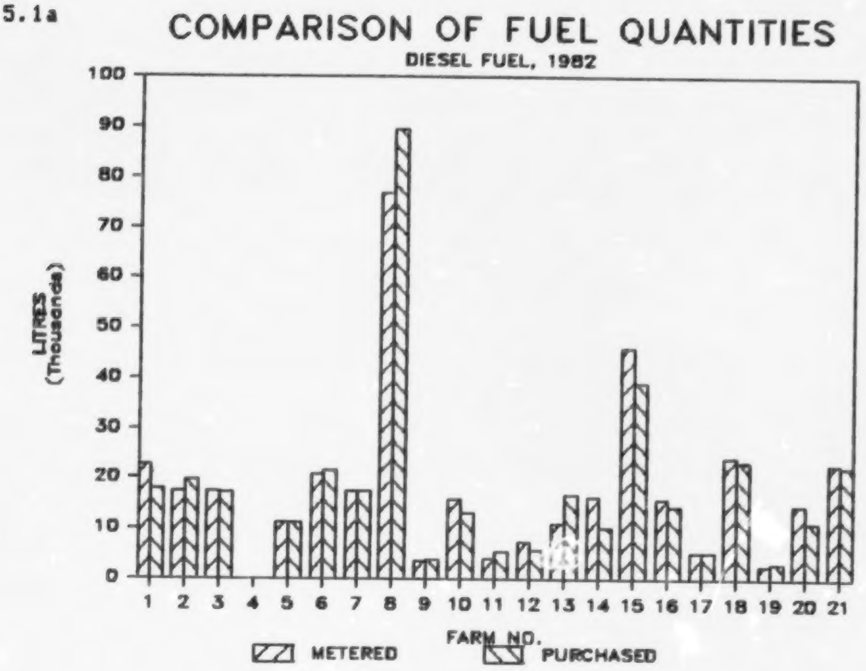
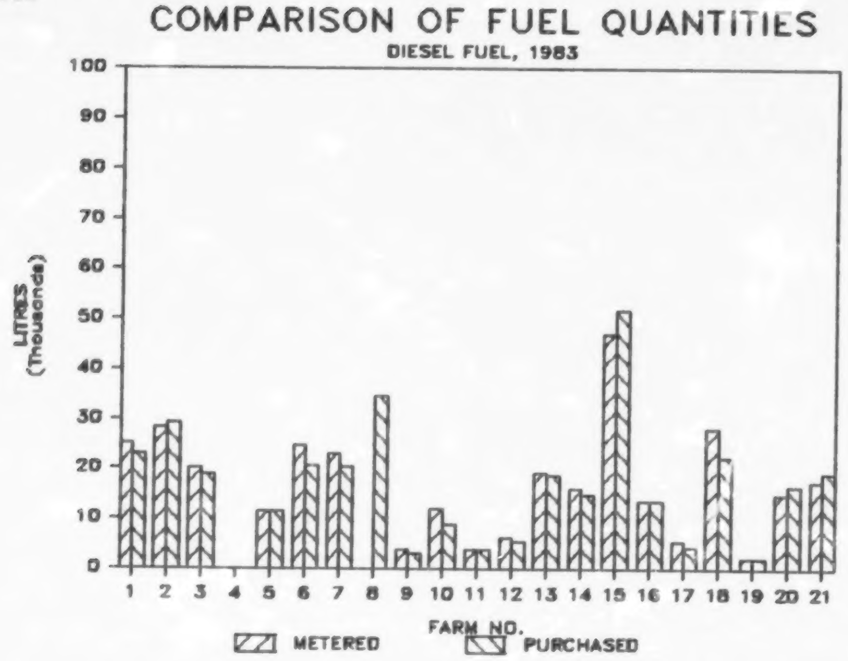


Figure 5.1b



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* Farm 8 was reduced in size in 1983, and its fuel use was not metered

** on Farm 13, not all fuel use was metered in 1982

Figure 5.2a

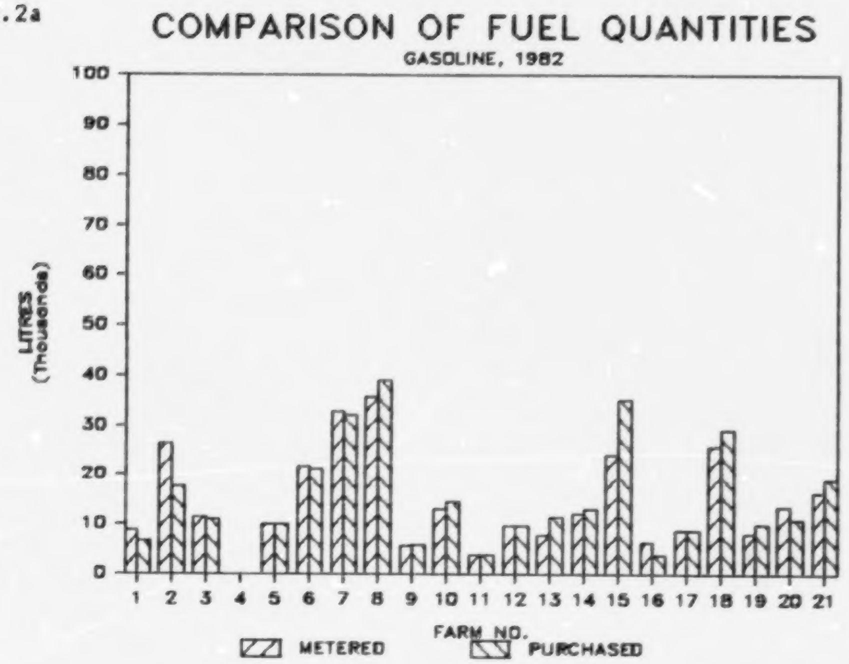
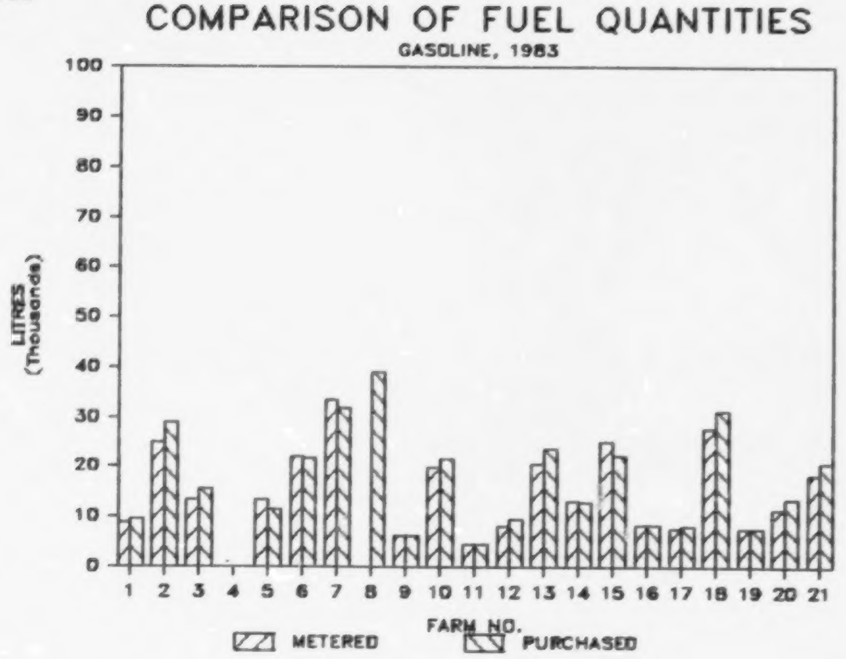


Figure 5.2b



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* Farm 8 was reduced in size in 1983, and its fuel use was not metered

** on Farm 13, not all fuel use was metered in 1982

Table 5.1a

TABLE 5.1a FUEL USE ON 20 SASKATCHEWAN FARMS, 1982, BY EQUIPMENT

					DIESEL FUEL USE (L)									GASOLINE USE (L)								
FARM NO.	LOCATION	CULT. (ha)	CROPS	LIVESTOCK	CARS+LT TRUCKS	HEAVY TRUCKS	TRACTORS	SWATHERS	COMBINES	OTHER PROD EQT	OTHER FARM USE	SUPPLIED TO OTHERS	TOTAL	CARS+LT TRUCKS	HEAVY TRUCKS	TRACTORS	SWATHERS	COMBINES	OTHER PROD EQT	OTHER FARM USE	SUPPLIED TO OTHERS	TOTAL
1	Weldon	549	Grain	Beef	2514	0	19064	0	0	982	0	246	22806	4156	3187	0	1212	0	15	87	40	8697
2	Calder	522	Grain & Hay	Beef	0	0	17261	0	0	0	33	0	17294	16947	4942	596	1262	1846	300	135	328	26356
3	Imperial	496	Grain	--	0	0	16903	0	0	0	0	556	17459	9644	1261	0	0	0	72	171	202	11350
5	Regina	514	Grain	--	0	0	11070	0	0	0	0	96	11166	6050	2534	789	191	0	126	260	125	10075
6	Tisdale	663	Grain & Hay	Beef	0	0	19485	0	0	1075	24	100	20684	15086	4416	816	1001	0	147	210	120	21796
7	Humboldt	699	Grain	Hogs	0	0	17255	0	0	0	10	260	17525	26295	2693	0	713	0	260	516	317	32794
8	Marsden	2144	Grain	--	2133	12279	61472	0	0	925	24	0	76833	21524	6161	1350	3085	0	1483	478	1541	35622
9	Landis	310	Grain & Hay	Sheep	0	0	2630	0	673	0	136	0	3439	4275	695	67	163	0	196	29	214	5641
10	Fargman	175	Hay	Dairy	0	9084	6688	0	0	0	94	0	15866	7679	215	190	86	0	4689	8	56	13123
11	Cochin	267	Grain & Hay	--	824	0	3266	0	0	0	0	0	4090	1128	1313	123	0	1007	43	12	0	3626
12	Humboldt	189	Grain & Hay	Beef	0	0	7250	0	0	0	0	0	7250	7781	1397	0	477	0	75	5	0	9735
13	Semans	533	Grain & Hay	Hogs	85	0	10398	0	309	119	0	0	10911	3613	3033	978	89	0	33	0	0	7748
14	Mossbank	813	Grain	--	0	0	16277	0	0	0	0	0	16277	9624	2002	100	0	0	242	166	105	12239
15	Heward	1737	Grain	--	0	6169	34905	0	4853	0	28	0	45955	18234	0	487	818	0	181	4474	0	24194
16	Kerrobert	608	Grain	--	0	0	15687	0	0	0	0	0	15687	3834	2046	0	60	0	32	317	50	6339
17	Gull Lake	350	Grain & Silage	Beef	0	0	4914	0	0	0	0	287	5201	5354	1523	0	0	1598	84	124	114	8797
18	McGee	1294	Grain	--	0	0	19279	0	4950	0	0	0	24229	16130	9684	0	0	0	0	0	0	25814
19	Maple Creek	120	Hay & Silage	Beef	0	0	2635	0	0	0	30	0	2665	7023	541	0	515	0	3	14	8	8104
20	Eston	958	Grain	--	0	0	14072	0	360	0	0	0	14432	10149	2740	0	113	51	118	381	73	13625
21	Cudworth	602	Grain & Silage	Dairy	0	0	22543	0	0	65	7	0	22615	7559	3530	0	1035	1669	311	363	1983	16450
				total	5556	27532	323054	0	11145	3166	386	1545	372384	204285	53913	5496	10820	6171	8414	7750	5276	302125
				%	1	7	87	0	3	1	0	0	100	68	18	2	4	2	3	3	2	100
				farm no.	%									%								
				1	11	0	84	0	0	4	0	1	100	48	37	0	14	0	0	1	0	100
				2	0	0	100	0	0	0	0	0	100	64	19	2	5	7	1	1	1	100
				3	0	0	97	0	0	0	0	3	100	85	11	0	0	0	1	2	2	100
				5	0	0	99	0	0	0	0	1	100	60	25	8	2	0	1	3	1	100
				6	0	0	94	0	0	5	0	0	100	69	20	4	5	0	1	1	1	100
				7	0	0	98	0	0	0	0	1	100	86	8	0	2	0	1	2	1	100
				8	3	16	80	0	0	1	0	0	100	60	17	4	9	0	4	1	4	100
				9	0	0	76	0	20	0	4	0	100	76	12	1	3	0	4	1	4	100
				10	0	57	42	0	0	0	1	0	100	60	2	1	1	0	36	0	0	100
				11	20	0	80	0	0	0	0	0	100	31	36	3	0	28	1	0	0	100
				12	0	0	100	0	0	0	0	0	100	80	14	0	5	0	1	0	0	100
				13	1	0	95	0	3	1	0	0	100	47	39	13	1	0	0	0	0	100
				14	0	0	100	0	0	0	0	0	100	79	16	1	0	0	2	1	1	100
				15	0	13	76	0	11	0	0	0	100	75	0	2	3	0	1	18	0	100
				16	0	0	100	0	0	0	0	0	100	60	32	0	1	0	1	5	1	100
				17	0	0	94	0	0	0	0	6	100	61	17	0	0	18	1	1	1	100
				18	0	0	80	0	20	0	0	0	100	62	38	0	0	0	0	0	0	100
				19	0	0	99	0	0	0	1	0	100	87	7	0	6	0	0	0	0	100
				20	0	0	98	0	2	0	0	0	100	74	20	0	1	0	1	3	1	100
				21	0	0	100	0	0	0	0	0	100	46	21	0	6	10	2	2	12	100

OTHER PRODUCTION EQUIPMENT: Augers, Front End Loaders, Backhoes, Pumps, Grain Dryers, Sprayers

OTHER FARM USE: Lawnmowers, Garden Tractors, Welders, Snowmobiles, Boats, Non-energy Use, Airplane (on farm 15 only, 4041 L)

Table 5.1b

TABLE 5.1b FUEL USE ON 21 SASKATCHEWAN FARMS, 1983, BY EQUIPMENT

FARM NO.	LOCATION	CULT. (ha)	CROPS	LIVESTOCK	DIESEL FUEL USE (L) CARS+LT TRUCKS	HEAVY TRUCKS	TRACTORS	SWATHERS	COMBINES	OTHER PROD EQT	OTHER FARM USE	SUPPLIED TO OTHERS	TOTAL	GASOLINE USE (L) CARS+LT TRUCKS	HEAVY TRUCKS	TRACTORS	SWATHERS	COMBINES	OTHER PROD EQT	OTHER FARM USE	SUPPLIED TO OTHERS	TOTAL
1	Beldon	571	Grain	Beef	2611	0	21961	0	0	507	0	80	25159	4072	3466	0	1058	0	0	24	175	8795
2	Calder	713	Grain & Hay	Beef	0	0	24332	0	3707	0	0	261	28300	17645	3290	131	2815	657	225	45	79	24887
3	Imperial	504	Grain	--	0	0	19706	0	0	0	0	231	19939	11828	900	0	0	0	145	370	108	13351
5	Regina	501	Grain	--	0	0	11395	0	0	0	3	0	11398	9483	2222	1106	263	0	103	155	37	13369
6	Tisdale	696	Grain & Hay	Beef	0	0	23983	0	0	631	4	0	24618	14219	4240	1086	1294	455	208	247	210	21959
7	Humboldt	662	Grain	Hogs	0	0	21569	0	220	56	0	995	22840	26798	4145	0	616	6	320	854	639	33380
9	Landis	312	Grain	Sheep	0	0	2696	0	916	0	130	0	3742	4668	887	48	166	0	179	91	137	6176
10	Pangman	176	Hay	Dairy	0	4000	7696	0	0	141	0	138	11975	9439	319	66	0	0	4396	25	5642	19875
11	Cochin	268	Grain & Hay	--	697	0	3007	0	0	0	0	0	3704	2450	496	385	0	1013	26	72	0	4444
12	Humboldt	160	Grain & Hay	Beef	0	0	6075	0	0	30	0	0	6105	6734	761	0	480	0	0	39	34	8090
13	Semans	535	Grain & Hay	Hogs	3510	0	15254	0	0	176	76	0	19016	15206	2856	1044	429	0	167	858	79	20641
14	Mossbank	820	Grain	--	0	0	15908	0	0	0	0	0	15908	10113	2559	15	0	0	233	127	0	13047
15	Howard	1730	Grain	--	0	6454	34929	0	5187	0	22	229	46821	19693	0	168	123	0	178	4784	66	25006
16	Kerrobert	628	Grain	--	0	0	13312	0	0	0	0	149	13461	4422	3395	0	69	0	125	249	35	8295
17	Gull Lake	345	Grain & Silage	Beef	0	0	5338	0	100	0	0	0	5438	4326	1588	0	0	1471	30	207	45	7669
18	McGee	1246	Grain	--	0	0	23559	0	4288	0	0	0	27847	19361	7738	0	242	0	339	0	0	27680
19	Maple Creek	121	Hay & Silage	Beef	0	0	2080	0	0	0	72	26	2178	6750	626	0	857	0	13	16	146	8408
20	Eston	968	Grain	--	0	0	14806	0	0	0	0	0	14806	6394	4643	0	58	0	137	116	21	11369
21	Cudworth	602	Grain & Silage	Dairy	0	0	17391	0	0	0	0	0	17391	8209	4120	0	750	1504	223	244	1382	16432
22	Kindersley	516	Grain		4100	0	3820	0	3627	50	0	0	11597	3062	3482	258	0	0	126	121	370	7439
23	Carragana	110	Grain		0	0	2500	0	0	0	0	91	2591	2730	945	0	0	0	0	0	0	3675
				total	10918	10454	291319	0	16047	1591	307	2200	332836	207626	52690	4301	9214	5100	7175	8644	11191	305941
				%	3	3	87	0	5	0	0	1	100	68	17	1	3	2	2	3	4	100
				farm no.																		
				1	10	0	87	0	0	2	0	0	100	46	39	0	12	0	0	0	2	100
				2	0	0	86	0	13	0	0	1	100	71	13	1	11	3	1	0	0	100
				3	0	0	99	0	0	0	0	1	100	89	7	0	0	0	1	3	1	100
				5	0	0	100	0	0	0	0	0	100	71	17	8	2	0	1	1	0	100
				6	0	0	97	0	0	3	0	0	100	65	19	5	6	2	1	1	1	100
				7	0	0	94	0	1	0	0	4	100	80	12	0	2	0	1	3	2	100
				9	0	0	72	0	25	0	3	0	100	76	14	1	3	0	3	1	2	100
				10	0	33	64	0	0	1	0	1	100	47	2	0	0	0	22	0	28	100
				11	19	0	81	0	0	0	0	0	100	55	11	9	0	23	1	2	0	100
				12	0	0	100	0	0	0	0	0	100	84	9	0	6	0	0	0	0	100
				13	18	0	80	0	0	1	0	0	100	74	14	5	2	0	1	4	0	100
				14	0	0	100	0	0	0	0	0	100	78	20	0	0	0	2	1	0	100
				15	0	14	75	0	11	0	0	0	100	79	0	1	0	0	1	19	0	100
				16	0	0	99	0	0	0	0	1	100	53	41	0	1	0	2	3	0	100
				17	0	0	98	0	2	0	0	0	100	56	21	0	0	19	0	3	1	100
				18	0	0	85	0	15	0	0	0	100	70	28	0	1	0	1	0	0	100
				19	0	0	96	0	0	0	3	1	100	80	7	0	10	0	0	0	2	100
				20	0	0	100	0	0	0	0	0	100	56	41	0	1	0	1	1	0	100
				21	0	0	100	0	0	0	0	0	100	45	22	0	4	9	1	1	18	100
				22	35	0	33	0	31	0	0	0	100	41	47	3	0	0	2	2	5	100
				23	0	0	96	0	0	0	0	4	100	74	26	0	0	0	0	0	0	100

OTHER PRODUCTION EQUIPMENT: Augers, Front End Loaders Backhoes, Pumps, Grain Dryers, Sprayers

OTHER FARM USE: Lawnmowers, Garden Tractors, Welders, Snowmobiles, Boats, Non-energy Use, Airplane (on farm 15 only, 4467L)

Summarized by major categories, the use of the two fuels on the aggregate of 20 (21) farms was distributed as shown in the following text tables and in Figures 5.3a (5.3b), 5.4a (5.4b) and 5.5a (5.5b).

1982	diesel fuel (%)	gasoline (%)
cars & light trucks	1.5	67.6
heavy trucks	7.4	17.8
airplane		1.3
total transportation equipment	8.9	86.8
tractors	86.8	1.8
swathers		3.6
combines	3.0	2.0
other production equipment	0.9	2.8
total production equipment	90.6	10.2
other	0.5	3.0
total	100.0	100.0

1983	diesel fuel (%)	gasoline (%)
cars & light trucks	3.3	67.9
heavy trucks	3.1	17.2
airplane		1.5
total transportation equipment	6.4	86.6
tractors	87.0	1.4
swathers		3.0
combines	5.4	1.7
other production equipment	0.5	2.3
total production equipment	92.9	8.4
other	0.7	5.0
total	100.0	100.0

While 91 (93) percent of the diesel fuel was used in production equipment, 87 (87) percent of the gasoline was used in transportation equipment in 1982 (1983).

Figure 5.3a

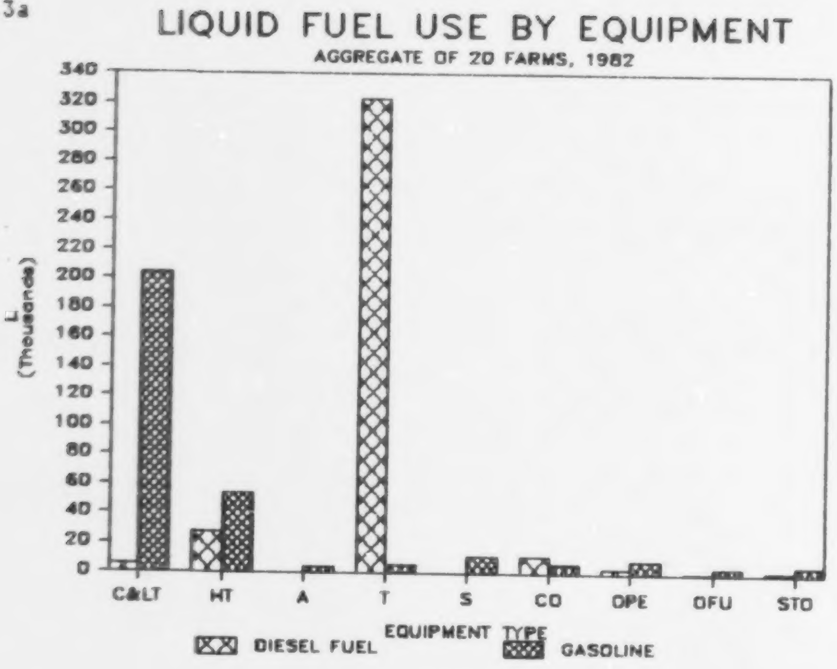
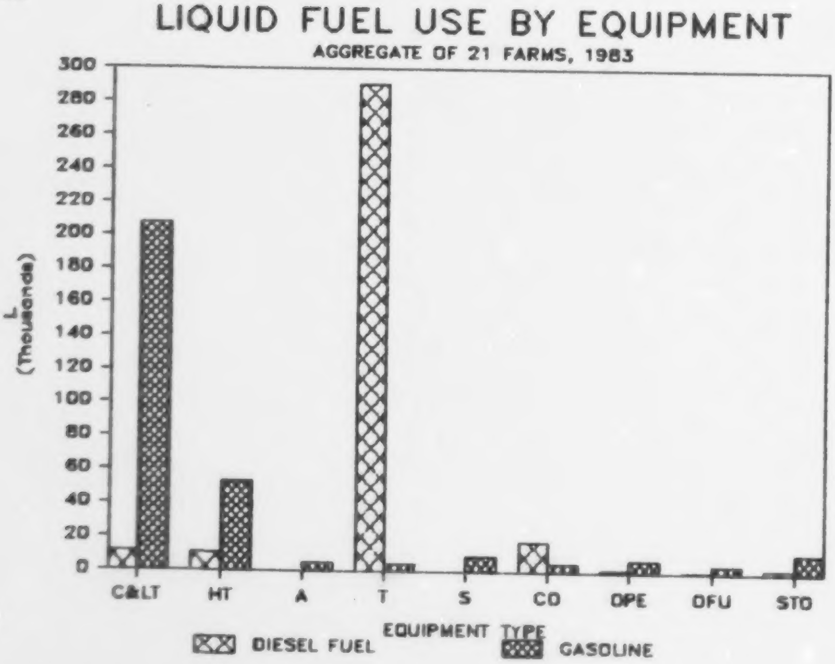


Figure 5.3b



C&LT=cars & light trucks
HT =heavy trucks
A =airplane
T =tractors
S =swathers
CO=combines
OPE=other production equipment
OFU=other farm use
STO=supplied to others

Figure 5.4a DIESEL FUEL USED FOR TRANSPORTATION
ON 20 FARMS, 1982

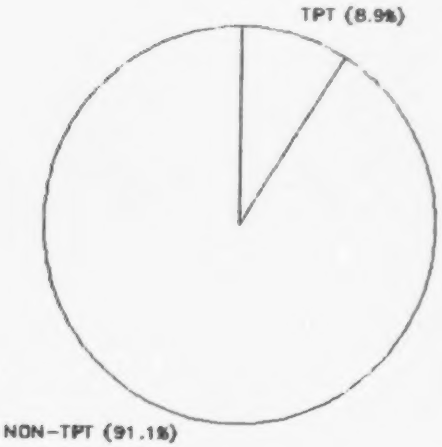
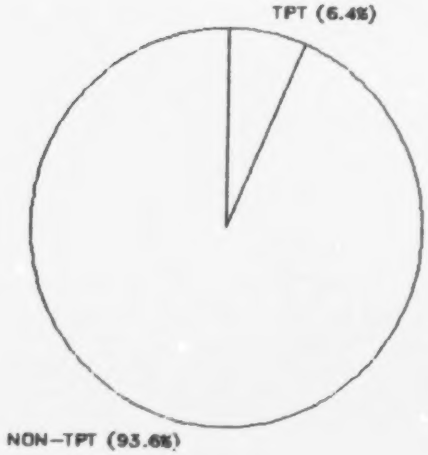


Figure 5.4b DIESEL FUEL USED FOR TRANSPORTATION
ON 21 FARMS, 1983



TPT =transportation
NON-TPT=other uses

Figure 5.5a GASOLINE USED FOR TRANSPORTATION
ON 20 FARMS, 1982

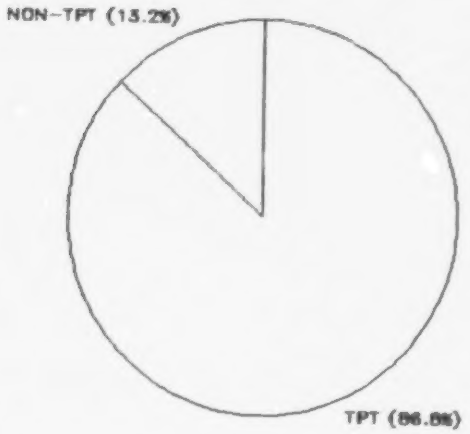
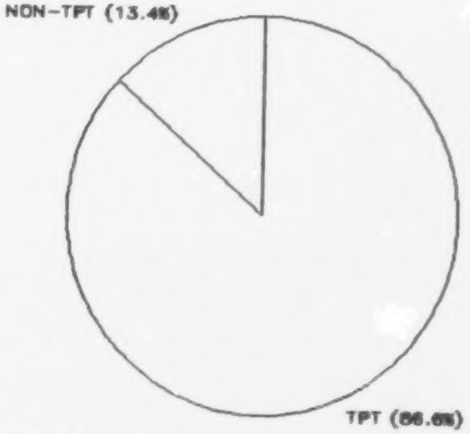


Figure 5.5b GASOLINE USED FOR TRANSPORTATION
ON 21 FARMS, 1983



TPT =transportation
NON-TPT=other uses

Table 5.2a (5.2b) shows the use of liquid fuels on the 20 (21) farms in 1982 (1983) by equipment type on an energy basis (diesel fuel valued at 38.7 MJ/L, gasoline at 34.5 MJ/L).

Summarized by major equipment categories, energy use in the form of liquid fuels on the aggregate of 20 (21) farms was distributed as shown in the following text tables and in Figures 5.6a (5.6b) and 5.7a (5.7b).

1982	diesel fuel (%)	gasoline (%)	total (%)
cars & light trucks	0.9	28.4	29.2
heavy trucks	4.3	7.5	11.8
airplane		0.6	0.6
total transportation equipment	5.2	36.4	41.6
production equipment	52.6	4.3	56.9
other	0.3	1.2	1.5
total	58.0	42.0	100.0

1983	diesel fuel (%)	gasoline (%)	total (%)
cars & light trucks	1.8	30.5	32.3
heavy trucks	1.7	7.7	9.5
airplane		0.7	0.7
total transportation equipment	3.5	38.9	42.4
production equipment	51.2	3.8	55.0
other	0.4	2.3	2.7
total	55.1	44.9	100.0

Transportation equipment (cars & light trucks, heavy trucks and one airplane) used 42 (42) percent of the total liquid fuel energy. Virtually all of the remainder was used by production equipment.

The distribution of liquid fuel energy use among the three major sectors (transport, tractors and other) varied widely as shown in Figure 5.8a (5.8b) and on a per hectare basis in Figure 5.9a (5.9b).

Diesel fuel met 58 (55) percent of the liquid fuel energy needs of the 20 (21) farms in 1982 (1983), while 42 (45) percent was met by gasoline (Figure 5.10a (5.10b)).

Table 5.2a

Table 5.2a LIQUID FUEL ENERGY USE ON 20 SASKATCHEWAN FARMS, 1982, BY EQUIPMENT

FARM NO.	LOCATION	CULT. (ha)	CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE — ENERGY USE (GJ): CARS+LT TRUCKS	HEAVY TRUCKS	TOTAL CARS & TRUCKS	TRACTORS	SWATHERS	COMBINES	OTHER PROD EQT	OTHER FARM USE	SUPPLIED TO OTHERS	TOTAL	ENERGY USE (%): CARS+LT TRUCKS	HEAVY TRUCKS	TOTAL CARS & TRUCKS	TRACTORS	SWATHERS	COMBINES	OTHER PROD EQT	OTHER FARM USE	SUPPLIED TO OTHERS	TOTAL
1	Meldon	549	Grain	Beef	241	110	351	738	42	0	39	3	11	1183	20	9	30	62	4	0	3	0	1	100
2	Calder	522	Grain & Hay	Beef	585	170	755	689	44	64	10	6	11	1579	37	11	48	44	3	4	1	0	1	100
3	Imperial	496	Grain	--	333	44	377	654	0	0	2	6	28	1067	31	4	35	61	0	0	0	1	3	100
5	Regina	514	Grain	--	209	87	296	456	7	0	4	9	8	780	27	11	38	58	1	0	1	1	1	100
6	Tisdale	663	Grain & Hay	Beef	520	152	672	782	35	0	47	8	8	1552	34	10	43	50	2	0	3	1	1	100
7	Humboldt	699	Grain	Hogs	976	93	1069	667	25	0	9	18	21	1810	54	5	59	37	1	0	0	1	1	100
8	Marsden	2144	Grain	--	825	688	1513	2426	106	0	87	17	53	4202	20	16	36	58	3	0	2	0	1	100
9	Landis	310	Grain & Hay	Sheep	147	24	171	104	6	26	7	6	7	328	45	7	52	32	2	8	2	2	2	100
10	Fangman	175	Hay	Dairy	272	359	631	265	3	0	162	4	2	1067	25	34	59	25	0	0	15	0	0	100
11	Cochin	267	Grain & Hay	--	71	45	116	131	0	35	1	0	0	283	25	16	41	46	0	12	0	0	0	100
12	Humboldt	189	Grain & Hay	Beef	268	48	316	281	16	0	3	0	0	616	44	8	51	46	3	0	0	0	0	100
13	Semans	532	Grain & Hay	Hogs	128	105	233	436	3	12	6	0	0	690	19	15	34	63	0	2	1	0	0	100
14	Mossbank	813	Grain	--	332	69	401	633	0	0	8	6	4	1052	32	7	38	60	0	0	1	1	0	100
15	Heward	1737	Grain	--	629	239	868	1368	28	188	6	155	0	2613	24	9	33	52	1	7	0	6	0	100
16	Kerrobert	608	Grain	--	132	71	203	607	2	0	1	11	2	826	16	9	25	73	0	0	0	1	0	100
17	Bull Lake	350	Grain & Silage	Beef	185	52	237	190	0	55	3	4	15	504	37	10	47	38	0	11	1	1	3	100
18	McGee	1294	Grain	--	556	334	890	746	0	192	0	0	0	1828	30	18	49	41	0	11	0	0	0	100
19	Maple Creek	120	Hay & Silage	Beef	242	19	261	102	18	0	0	2	0	383	63	5	68	27	5	0	0	1	0	100
20	Eston	958	Grain	--	350	95	445	545	4	16	4	13	3	1029	34	9	43	53	0	2	0	1	0	100
21	Cudworth	602	Grain & Silage	Dairy	261	122	383	872	36	58	13	13	68	1443	18	8	27	60	2	4	1	1	5	100
				total	7262	2926	10188	12692	375	646	412	281	241	24835										
				%	29	12	41	51	2	3	2	1	1	100										

OTHER PRODUCTION EQUIPMENT: Augers, Front End Loaders, Backhoes, Pumps, Grain Dryers, Sprayers

OTHER FARM USE: Lawnmowers, Garden Tractors, Welders, Snowmobiles, Boats, Non-energy Use, Airplane (on farm 15 only, 139 GJ)

Table 5.2b

Table 5.2b LIQUID FUEL ENERGY USE ON 21 SASKATCHEWAN FARMS, 1983, BY EQUIPMENT

				USE OF DIESEL FUEL AND GASOLINE																			
				ENERGY USE (GJ)										ENERGY USE (%)									
FARM NO.	LOCATION	CULT. (ha)	CROPS	LIVESTOCK	CARS+LT TRUCKS	HEAVY TRUCKS	TOTAL CARS & TRUCKS	TRACTORS	SWATHERS	COMBINES	OTHER PROD EQT	OTHER FARM USE	SUPPLIED TO OTHERS	TOTAL	CARS+LT TRUCKS	HEAVY TRUCKS	TOTAL CARS & TRUCKS	TRACTORS	SWATHERS	COMBINES	OTHER PROD EQT	OTHER FARM USE	SUPPLIED TO OTHERS	TOTAL
1	Weldon	571	Grain	Beef	242	120	362	856	37	0	20	1	9	1279	19	9	28	66	3	0	2	0	1	100
2	Calder	713	Grain & Hay	Beef	609	114	723	946	97	166	8	2	13	1955	31	6	37	48	5	8	0	0	1	100
3	Imperial	504	Grain	--	406	31	439	763	0	0	5	13	12	1232	33	3	36	62	0	0	0	1	1	100
5	Regina	561	Grain	--	327	77	404	479	9	0	4	5	1	902	36	9	45	53	1	0	0	1	0	100
6	Tisdale	696	Grain & Hay	Beef	491	146	637	966	45	16	32	9	7	1712	29	9	37	56	3	1	2	1	0	100
7	Humboldt	686	Grain	Hogs	925	143	1068	835	21	9	13	29	61	2036	45	7	52	41	1	6	1	1	3	100
9	Landis	312	Grain	Sheep	161	31	192	106	6	36	6	8	5	359	45	9	53	30	2	10	2	2	1	100
10	Fangman	176	Hay	Dairy	326	166	492	300	0	0	157	1	200	1150	28	14	43	26	0	0	14	0	17	100
11	Cochin	266	Grain & Hay	--	111	17	128	130	0	35	1	2	0	296	38	6	43	44	0	12	0	1	0	100
12	Humboldt	180	Grain & Hay	Beef	232	26	258	235	17	0	1	1	1	513	45	5	50	46	3	0	0	0	0	100
13	Semans	535	Grain & Hay	Hogs	660	99	759	626	15	0	13	33	3	1449	46	7	52	43	1	0	1	2	0	100
14	Mossbank	820	Grain	--	349	88	437	616	0	0	8	4	0	1065	33	8	41	58	0	0	1	0	0	100
15	Howard	1730	Grain	--	679	250	929	1358	4	201	6	166	11	2675	25	9	35	51	0	8	0	6	0	100
16	Kerrobert	626	Grain	--	153	117	270	515	2	0	4	9	7	807	19	14	33	64	0	0	0	1	1	100
17	Gull Lake	345	Grain & Silage	Beef	149	55	204	207	0	55	1	7	2	476	31	12	43	43	0	12	0	1	0	100
18	McGee	1246	Grain	--	668	267	935	912	0	166	12	0	0	2033	33	13	46	45	0	8	1	0	0	100
19	Maple Creek	121	Hay & Silage	Beef	233	22	255	80	30	0	0	3	6	374	62	6	68	21	8	0	0	1	2	100
20	Eston	968	Grain	--	221	160	381	573	2	0	5	4	1	966	23	17	39	59	0	0	1	0	0	100
21	Cudworth	603	Grain & Silage	Dairy	283	142	425	673	26	52	8	0	117	1309	22	11	32	51	2	4	1	1	9	100
22	Kindersley	518	Grain		265	120	385	157	0	140	6	4	13	705	38	17	55	22	0	20	1	1	2	100
23	Carragana	110	Grain		94	33	127	97	0	0	0	6	4	228	41	14	56	43	0	0	0	0	2	100
				total	7586	2224	9810	11424	319	676	310	309	473	23521										
				%	32	9	42	49	1	4	1	1	2	100										

OTHER PRODUCTION EQUIPMENT: Augers, Front End Loaders, Backhoes, Pumps, Grain Dryers, Sprayers
OTHER FARM USE: Lawnmowers, Garden Tractors, Welders, Snowmobiles, Boats, Non-energy Use, Airplane (on farm 15 only, 155 GJ)

Figure 5.6a

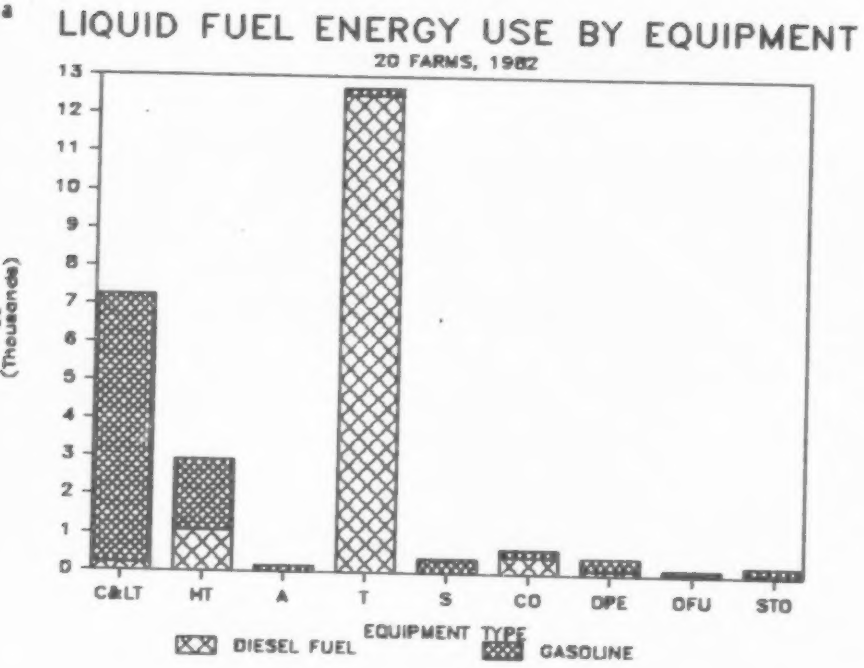
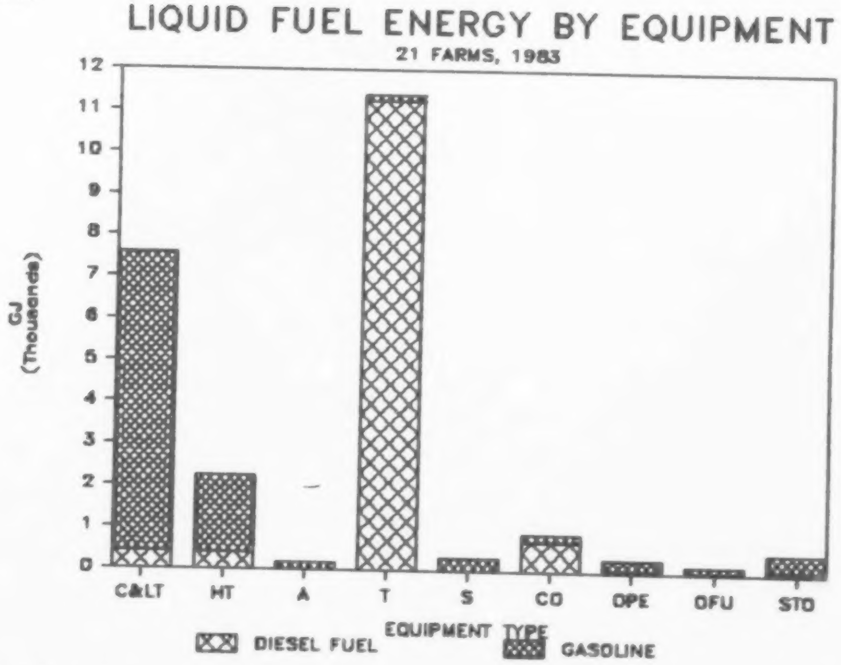


Figure 5.6b



C&LT=cars & light trucks
HT =heavy trucks
A =airplane
T =tractors
S =swathers
CO=combines
OPE=other production equipment
OFU=other farm use
STO=supplied to others

Figure 5.7a ENERGY CONTENT OF LIQUID FUELS USED
ON 20 FARMS, BY EQUIPMENT, 1982

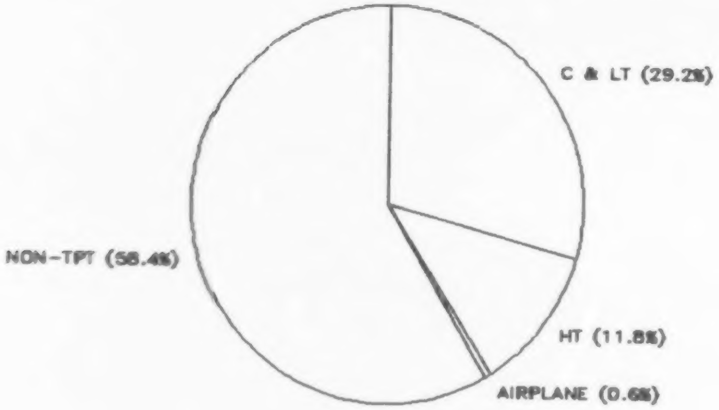
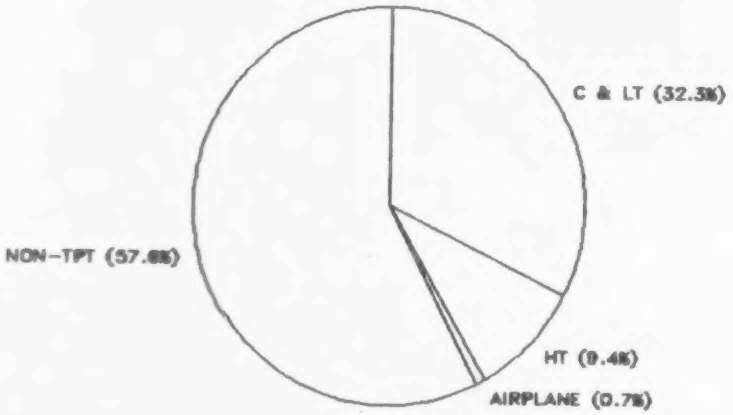


Figure 5.7b
ENERGY CONTENT OF LIQUID FUELS USED
ON 21 FARMS, BY EQUIPMENT, 1983



TPT =transportation
NON-TPT=other uses

Figure 5.8a

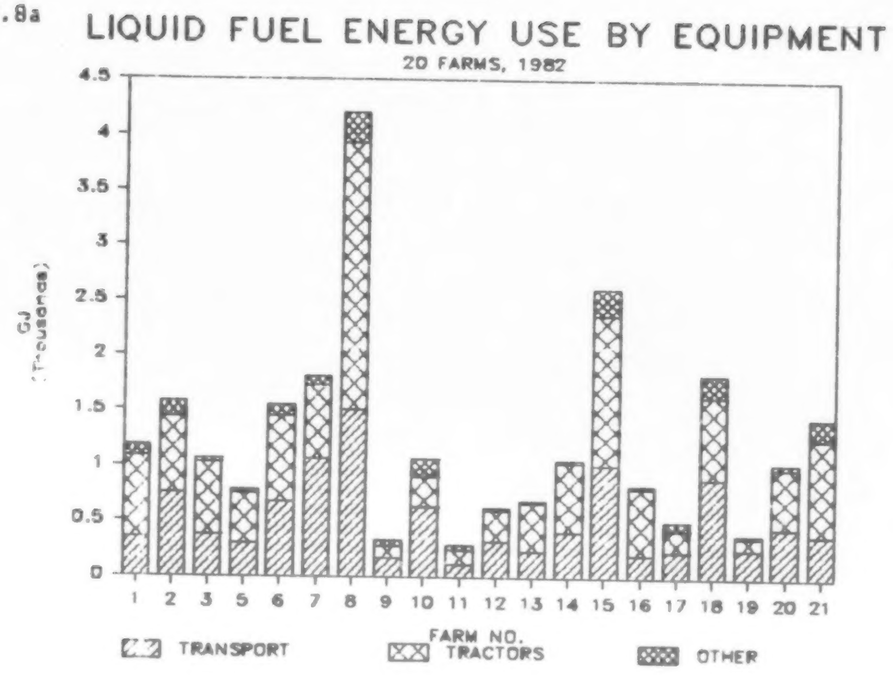


Figure 5.8b

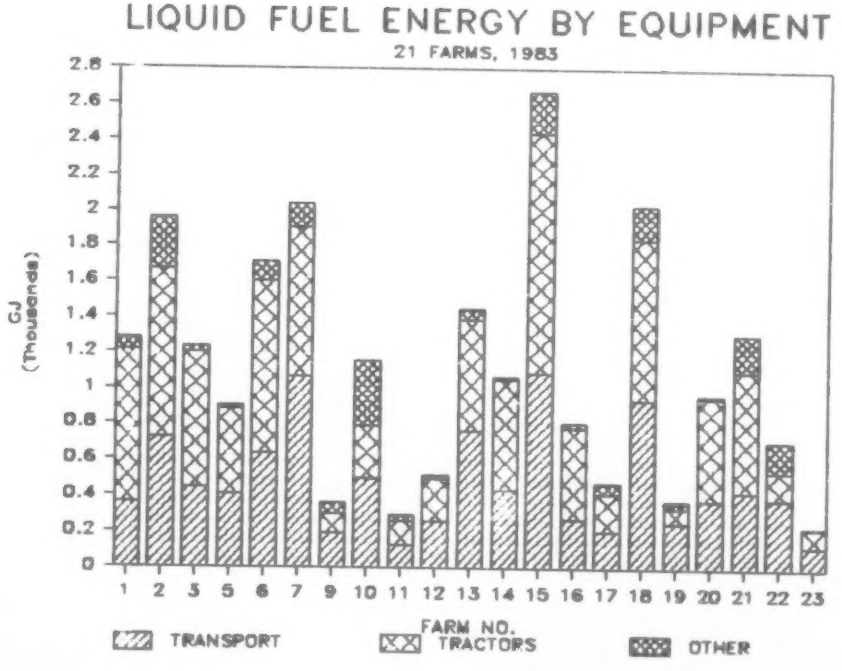


Figure 5.9a

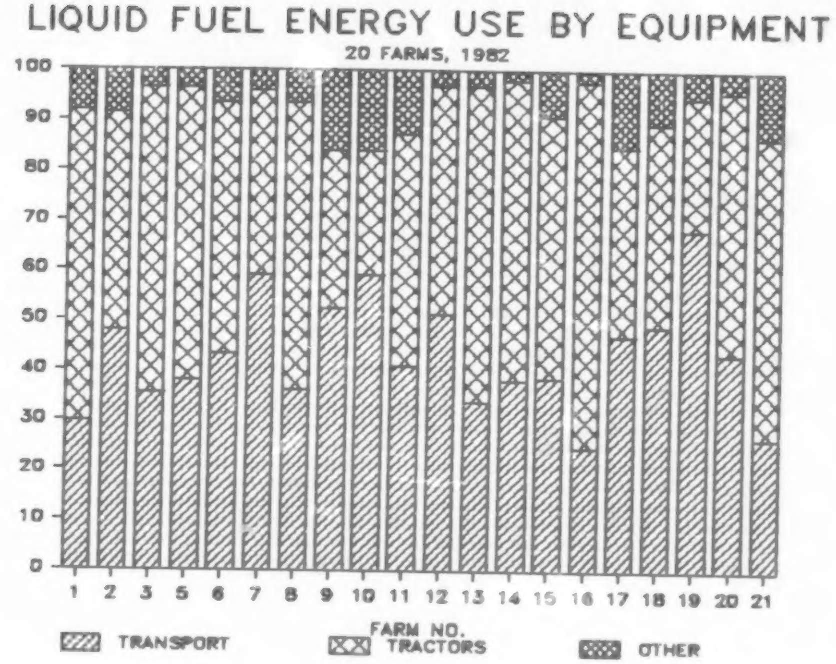


Figure 5.9b

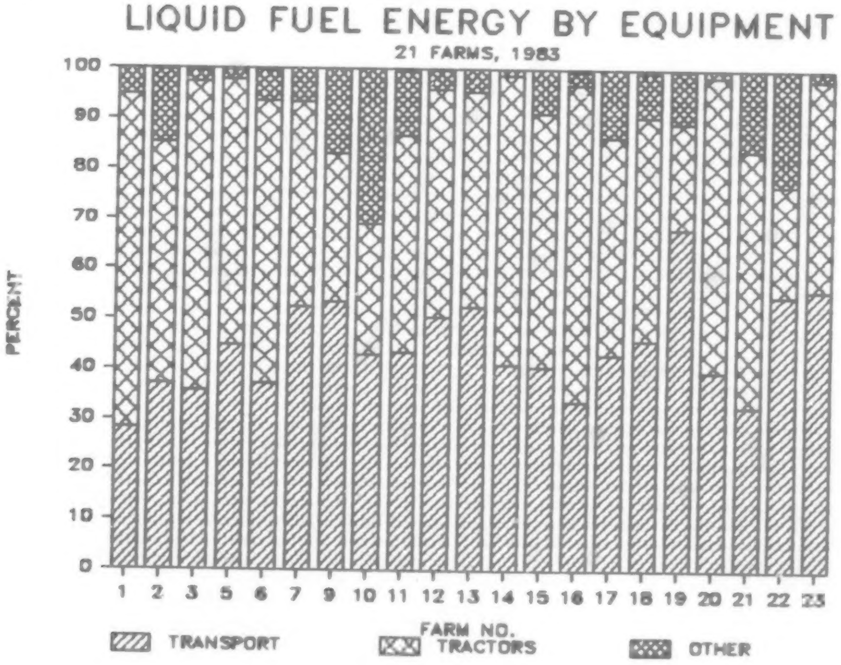


Figure 5.10a ENERGY CONTENT OF LIQUID FUELS USED
ON 20 FARMS, BY FUEL, 1982

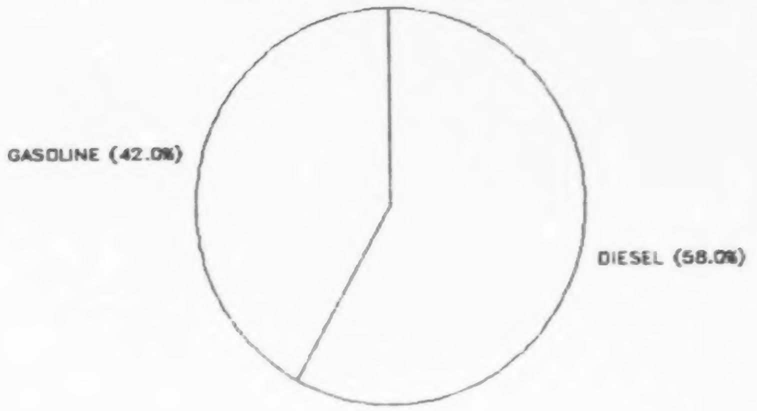
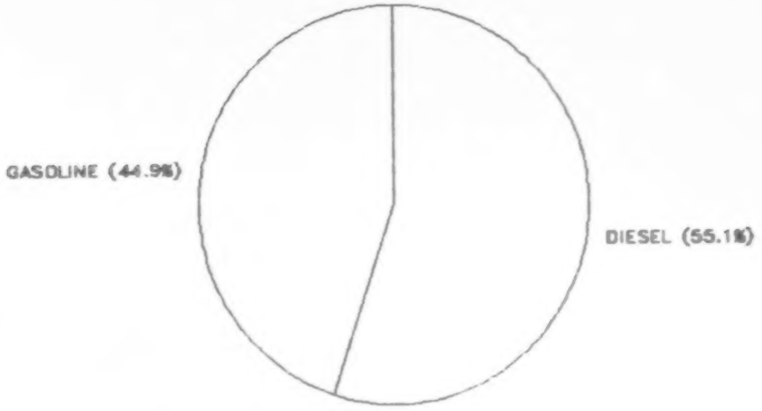


Figure 5.10b ENERGY CONTENT OF LIQUID FUELS USED
ON 21 FARMS, BY FUEL, 1983



Liquid Fuel Use by Transportation Equipment

As shown in the previous section (p. 5.14) cars and light trucks used 2 (3) percent of the diesel fuel and 68 (68) percent of the gasoline. Heavy trucks used 7 (3) percent of the diesel fuel and 18 (17) percent of the gasoline. The two categories of vehicles, together with one airplane, used 9 (6) percent of the diesel fuel and 87 (87) percent of the gasoline.

In terms of energy, heavy trucks accounted for 12 (10) percent of the liquid fuel use, cars and light trucks for 29 (32) percent. The total transportation sector, including one airplane, accounted for 42 (42) percent of the use of these fuels.

A list of the vehicles operated on the 20 farms in 1982 was compiled from the "Liquid Fuel Use and Fuel Use Rate by Equipment, 1982" reports generated by the fuel log data base program.

Out of the 131 vehicles for which fuel use records were kept, there were 86 for which records of distances travelled had also been kept, at least part of the time. For these, fuel efficiencies were calculated. The cooperators, when shown these calculated efficiencies, agreed that they were accurate. We then asked them to supply fuel efficiencies for the vehicles for which these could not be calculated from the records. This they did. The total distance travelled by each of these vehicles was then calculated by dividing the fuel used during the year by the fuel efficiency. The vehicle records were then sorted in four groups (diesel fuel and gasoline, each subdivided in cars & light trucks and heavy trucks), and average fuel efficiencies were calculated for each group for both 1982 and 1983.

Four diesel-powered cars and light trucks averaged 9.8 L/100 km (28.8 mpg) in 1982 (Table 5.3a). This group included the most efficient of all vehicles in the program, a 1980 half-ton Volkswagen truck for which a fuel efficiency of 7.6 L/100 km (37.1 mpg) was calculated. In 1983, four diesel-powered cars and light trucks (only half of which were carried over from the previous year) averaged 11.3 L/100 km (25.0 mpg) (Table 5.3b).

Four diesel-powered heavy trucks averaged 67.9 L/100 km (4.2 mpg) in 1982 (Table 5.4a). This group consisted of two semis and two tandem trucks. In 1983, two diesel-powered heavy trucks averaged 55.6 L/100 km (5.1 mpg) (Table 5.4b). It should be noted that L/(t.km) would be a more appropriate unit for measuring the fuel efficiency of heavy trucks. However, the data for calculating this were not collected.

In 1982, the 81 gasoline-powered cars and light trucks for which fuel efficiencies were available averaged 17.7 L/100 km (15.9 mpg). The sub-group of 35 cars averaged 13.7 L/100 km (20.6 mpg) (Table 5.5a). The sub-group of 44 light trucks and two vans averaged 21.0 L/100 km (13.4 mpg) (Table 5.6a). In 1983, the 78 gasoline-powered cars and light trucks for which fuel efficiencies were available averaged 17.9 L/100 km (15.8 mpg). The sub-group of 33 cars averaged 13.7 L/100 km (20.6 mpg) (Table 5.5b). The sub-group of 44 light trucks and one van averaged 20.4 L/100 km (13.8 mpg) (Table 5.6b).

Table 5.3a

Diesel Fuel - Cars & Light Trucks, 1982

FARM VEHICLE NO		FUEL USED (L)	FUEL EFFICIENCY (L/100km)	DISTANCE DRIVEN 1982 (km/a)
1 Car, Oldsmobile, 1979		2514	11.7	21487
8 Truck, 1/2 ton, Volksw, 1980		2133	7.6	28066
11 Truck, 1/2 ton, GMC, 1978		824	12.4	6645
13 Car, Pontiac, 1981		85	14.2	599
	4	5556	9.8	56797

Table 5.3b

Diesel Fuel - Cars & Light Trucks, 1983

FARM VEHICLE NO		FUEL USED (L)	FUEL EFFICIENCY (L/100km)	DISTANCE DRIVEN 1983 (km/a)
1 Car, Oldsmobile, 1979		2611	11.7	22316
11 Truck, 1/2 ton, GMC, 1978		697	11.3	6168
13 Car, Pontiac, 1981		3510	8.7	40345
22 Car, Chev Wagon, 1980		4100	14.6	28082
	4	10918	11.3	96911

Table 5.4a

Diesel Fuel - Heavy Trucks, 1982

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100km)	DISTANCE DRIVEN 1982 (km/a)
8	Truck, semi, Ford 9000, 1979	6287	71.9	8744
8	Truck, tandem, IHC, 1981	5992	62.5	9587
10	Truck, IHC 4070a, 1977	9084	77.4	11736
15	Truck, tandem, Ford, 1971	6169	58.9	10474
	4	27532	67.9	40541

Table 5.4b

Diesel Fuel - Heavy Trucks, 1983

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100km)	DISTANCE DRIVEN 1983 (km/a)
10	Truck, IHC 4070a, 1977	4000	51.0	7843
15	Truck, tandem, Ford, 1971	6454	58.9	10958
	2	10454	55.6	18801

Table 5.5a

Gasoline - Cars, 1982

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100km)	DISTANCE DRIVEN 1982 (km/a)
1	Car, Plymouth, 1976	1546	18.1	8541
2	Car, Toyota, 1971	661	11.3	5850
2	Car, Dodge Dart, 1971	1810	15.9	11384
2	Car, Dodge Coronet, 1975	1528	15.7	9732
2	Car, Buick Skylark, 1975	1078	15.7	6866
2	Car, Dodge K-car, 1981	2964	9.8	30245
3	Car, Mercury, 1981	2989	12.9	23171
5	Car, Dodge Dart, 1967	1344	12.7	10583
5	Car, Oldsmobile, 1979	2691	14.0	19221
6	Car, Chrysler, 1969	1693	22.2	7626
6	Car, Datsun, 1970	1120	11.1	10090
7	Car, Chevrolet 1974	3319	21.4	15509
7	Car, Pontiac, 1979	2768	14.2	19493
7	Car, Buick, 1980	3357	16.3	20595
8	Car, Ford Meteor, 1976	1097	19.5	5626
8	Car, Ford LTD, 1979	2416	20.0	12080
8	Car, Lincoln, 1979	3187	17.8	17904
8	Car, Chevrolet Z-28, 1983	705	21.4	3294
9	Car, Valiant (borrowed)	144	13.3	1083
9	Car, Ford Fairlane, 1968	156	14.0	1114
9	Car, Plymouth, 1970	6	14.0	43
10	Car, Dodge, 1979	2793	14.2	19669
11	Car, Ford Pinto, 1978	1128	8.7	12966
12	Car, Datsun, 1974	1464	10.2	14353
12	Car, Chevrolet Malibu, 1978	3336	13.9	24000
14	Car, Mercury, 1975	1196	17.7	6757
14	Car, Mercury Lynx, 1981	1380	8.5	16235
14	Car, Oldsmobile, 1982	1437	11.3	12717
15	Car, Mercury, 1978	3500	16.6	21084
15	Car, Mercury, 1980	2300	12.8	17969
16	Car, Citation, 1980	2595	11.8	21992
17	Car, Cordoba, 1979	3135	12.8	24492
18	Car, Oldsmobile, 1981	3530	10.0	35300
19	Car, Toyota, 1976	819	10.4	7875
20	Car, Chrysler, 1972	7792	14.0	55657
	35	72984	13.7	531116

Table 5.5b

Gasoline - Cars, 1983

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100km)	DISTANCE DRIVEN 1983 (km/a)
1	Car, Plymouth, 1976	941	17.9	5257
2	Car, Dodge Dart, 1971	2410	19.6	12296
2	Car, Toyota, 1971	469	11.3	4150
2	Car, Dodge Coronet, 1975	1132	15.7	7210
2	Car, Buick Skylark, 1975	1178	15.3	7699
2	Car, Dodge K-car, 1981	2621	9.1	28802
3	Car, Mercury, 1981	3843	13.5	28467
5	Car, Dodge Dart, 1967	912	15.0	6080
5	Car, Valiant, 1975	1719	15.7	10949
5	Car, Nova, 1976	1630	13.4	12164
5	Car, Oldsmobile, 1979	3013	15.9	18950
6	Car, Chrysler, 1969	914	19.7	4640
6	Car, Datsun, 1970	935	9.2	10163
6	Car, Ford Escort, 1982	1568	8.7	18023
7	Car, Chevrolet 1974	2565	20.1	12761
7	Car, Pontiac, 1979	2343	16.5	14200
7	Car, Buick, 1980	4211	16.8	25065
9	Car, Valiant (borrowed)	400	13.1	3053
10	Car, Dodge, 1979	4196	19.2	21854
11	Car, Ford Pinto, 1978	1705	9.5	17947
12	Car, Chevrolet Malibu, 1978	3748	18.9	19831
13	Car, Chevelle, 1969	1372	27.1	5063
14	Car, Mercury, 1975	1700	22.0	7727
14	Car, Oldsmobile, 1982	2500	11.3	22124
15	Car, Mercury, 1978	3650	16.6	21988
15	Car, Mercury, 1980	2050	12.8	16016
16	Car, Citation, 1980	2649	11.8	22449
17	Car, Cordoba, 1979	2711	12.9	21016
18	Car, Oldsmobile, 1981	5961	10.0	59610
19	Car, Toyota, 1976	2040	10.4	19615
20	Car, Chrysler, 1972	1882	14.0	13443
23	Car, Ford Falcon, 1960	527	12.6	4183
23	Car, Mercury Monarch, 1977	2203	11.4	19325
	33	71698	13.7	522120

Table 5.6a

Gasoline - Light Trucks & Vans, 1982

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100km)	DISTANCE DRIVEN 1982 (km/a)
1	Truck, 1/2 ton, Ford, 1976	2610	25.5	10235
2	Truck 3/4 ton, Dodge, 1979	5462	22.8	23956
2	Van, Dodge, 1981	3444	20.8	16558
3	Truck, 3/4 ton, Chev, 1975	6395	37.9	16873
3	Truck, 1/2 ton, Ford, 1980	260	23.5	1106
5	Truck, 1/2 ton, Ford, 1974	2015	26.0	7750
6	Truck, 1/2 ton, Chev, 1969	1267	22.5	5631
6	Truck, 1/2 ton, Chev, 1970	1332	15.9	8377
6	Truck, 3/4 ton, Ford, 1980	8371	21.9	38224
6	Truck, 1/2 ton, Dodge, 1982	1303	22.0	5923
7	Truck, 1/2 ton, GMC, 1974	1670	25.6	6523
7	Truck, 1/2 ton, GMC, 1978	4305	16.0	26906
7	Truck, 1/2 ton, GMC, 1979	8558	22.3	38377
7	Truck, 1/2 ton, GMC, 1982	4318	16.8	25702
8	Truck, 1/2 ton, Chev, 1972	707	23.5	3009
8	Truck, 1/2 ton, Chev, 1978	1106	33.6	3292
8	Van, Ford 150, 1978	1632	38.5	4239
8	Truck, 1/2 ton, Ford 1980	7308	24.5	29829
8	Truck,1/2 ton, Chev S10, 1982	2518	12.1	20810
9	Truck, 1/2 ton, Fargo, 1968	350	26.9	1301
9	Truck, 1/2 ton, GMC, 1976	3619	16.2	22340
10	Truck, 3/4 ton (rented)	230	26.0	885
10	Truck, 1/2 ton, Dodge, 1976	4856	21.1	23014
12	Truck, 1/2 ton, GMC, 1971	2981	24.9	11972
13	Truck, Mazda 1600, 1971	611	8.0	7638
13	Truck, 1/2 ton, Chev, 1978	3002	22.0	13645
14	Truck, 1/2 ton, Chev S15, 1982	2076	9.9	20970
14	Truck, 1/2 ton, Chev, 1982	3535	13.6	25993
15	Truck, 1/2 ton, Ford, 1973	3745	23.5	15936
15	Truck, 3/4 ton, Ford, 1974	7051	26.1	27015
15	Truck, Ford Ranger, 1983	1178	11.3	10425
15	Truck, Ford 250, 1983	460	14.8	3108
16	Truck, 1/2 ton, Chev, 1966	313	18.7	1674
16	Truck, Ford F-150, 1981	926	30.0	3087
17	Truck, 1/2 ton, Ford 100, 1979	2219	20.2	10985
18	Truck, 1/2 ton, Chev, 1975	900	24.9	3614
18	Truck, 1/2 ton, Chev, 1978	6800	22.8	29825
18	Truck, 1/2 ton, Chev, 1980	4900	24.0	20417
19	Truck, Toyota, 1976	2146	27.4	7832
19	Truck, 1/2 ton, Ford, 1980	4058	18.6	21817
20	Truck, 1/2 ton, Dodge, 1964	1328	20.7	6415
20	Truck, 1/2 ton, Ford, 1966	60	20.0	300
20	Truck, 1/2 ton, GMC, 1976	969	28.0	3461
21	Truck, 3/4 ton, Ford, 1976	353	25.1	1406
21	Truck, 1/2 ton, F150, 1978	4890	20.2	24208
21	Truck, 4x4, Chev, 1980	2316	27.8	8331
	46	130453	21.0	620933

Table 5.6b

Gasoline - Light Trucks & Vans, 1983

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100km)	DISTANCE DRIVEN 1983 (km/a)
1	Truck, 1/2 ton, Ford, 1976	3131	21.7	14429
2	Truck 3/4 ton, Dodge, 1979	5638	28.2	19993
2	Van, Dodge, 1981	4197	17.9	23447
3	Truck, 3/4 ton, Chev, 1975	7939	38.0	20892
3	Truck, 1/2 ton, Ford, 1980	46	23.5	196
5	Truck, 1/2 ton, Ford, 1974	2209	26.3	8399
6	Truck, 1/2 ton, Chev, 1969	690	24.4	2828
6	Truck, 1/2 ton, Chev, 1970	1162	19.7	5898
6	Truck, 3/4 ton, Ford, 1980	6681	24.5	27269
6	Truck, 1/2 ton, Dodge, 1982	2183	19.3	11311
7	Truck, 1/2 ton, GMC, 1974	1871	31.6	5921
7	Truck, 1/2 ton, GMC, 1978	3605	17.6	20483
7	Truck, 1/2 ton, GMC, 1979	1968	22.3	8825
7	Truck, 1/2 ton, GMC, 1982	4282	16.8	25488
7	Truck, 4x4, GMC, 1983	5458	17.8	30663
7	Truck, 1/2 ton, GMC, 1984	495	20.5	2415
9	Truck, 1/2 ton, Fargo, 1968	713	20.8	3428
9	Truck, 1/2 ton, GMC, 1976	3555	15.8	22500
10	Truck, 3/4 ton (rented)	323	26.0	1242
10	Truck, 1/2 ton, Dodge, 1976	4920	20.8	23654
12	Truck, 1/2 ton, GMC, 1971	2988	20.3	14719
13	Truck, Mazda 1600, 1971	1244	15.2	8184
13	Truck, 1/2 ton, Chev, 1976	5436	20.9	26010
13	Truck, 1/2 ton, Chev, 1978	7154	21.1	33905
14	Truck, 1/2 ton, Chev, 1982	3651	13.8	26457
14	Truck, 1/2 ton, Chev S15, 1982	2262	9.9	22848
15	Truck, 3/4 ton, Ford, 1973	1002	25.2	3976
15	Truck, 3/4 ton, Ford, 1974	2692	26.3	10236
15	Truck, Ford 250, 1983	5660	17.6	32159
15	Truck, Ford Ranger, 1983	3050	11.3	26991
15	Truck, 1/2 ton, Ford, 1983	1589	24.0	6621
16	Truck, 1/2 ton, Chev, 1966	352	20.8	1692
16	Truck, Ford F-150, 1981	1421	18.7	7599
17	Truck, 1/2 ton, F100, 1979	1617	16.6	9741
18	Truck, 1/2 ton, Chev, 1975	5590	24.9	22450
18	Truck, 1/2 ton, Chev, 1978	7810	22.8	34254
19	Truck, 1/2 ton, Ford, 1980	2997	16.1	18615
19	Truck, Toyota, 1976	1713	26.2	6538
20	Truck, 1/2 ton, Dodge, 1964	937	20.7	4527
20	Truck, 1/2 ton, GMC, 1976	1532	28.0	5471
20	Truck, 1/2 ton, Dodge, 1977	2043	19.5	10477
21	Truck, 1/2 ton, F150, 1978	4399	20.2	21777
21	Truck, 4x4, Chev, 1980	3810	23.0	16565
22	Truck, 1/2 ton, GMC, 1970	2000	25.1	7968
22	Truck, 1/2 ton, GMC, 1973	1082	24.5	4416
	45	135097	20.4	663478

In 1982, the 38 gasoline-powered heavy trucks for which fuel efficiencies were available averaged 44.0 L/100 km (6.4 mpg) (Table 5.7a). In 1983, the 37 heavy trucks in this group averaged 44.3 L/100 km (6.4 mpg) (Table 5.7b).

Further analysis by vehicle type regardless of fuel type gave the following results:

Cars

In 1982, the 36 cars for which fuel efficiency records were available, had a median age of 5 years (the average age was 7) and their average fuel efficiency was 13.7 L/100 km (20.6 mpg) (Table 5.8a). Cars older than the median age averaged 14.6 L/100 km (19.3 mpg), cars newer than the median age averaged 13.2 L/100 km (21.4 mpg). Figure 5.11a shows the variation of fuel efficiency with age.

The range of efficiencies for these cars was 22.2 to 8.5 L/100 km (12.7 to 33.2 mpg) (Table 5.9a). The median efficiency of the cars was 14.0 L/100 km (20.1 mpg). Cars less efficient than the median averaged 16.3 L/100 km (17.3 mpg), cars more efficient than the median averaged 11.3 L/100 km (25.0 mpg).

In 1983, the 35 cars for which fuel efficiency records were available, had a median age of 6 years (the average age was 8) and their average fuel efficiency was 13.4 L/100 km (21.0 mpg) (Table 5.8b). Cars older than the median age averaged 15.1 L/100 km (18.7 mpg), cars newer than the median age averaged 12.9 L/100 km (21.9 mpg). Figure 5.11b shows the variation of fuel efficiency with age.

The range of efficiencies for these cars was 27.1 to 8.7 L/100 km (10.4 to 32.4 mpg) (Table 5.9b). The median efficiency of the cars was 13.5 L/100 km (20.9 mpg). Cars less efficient than the median averaged 17.3 L/100 km (16.3 mpg), cars more efficient than the median averaged 10.6 L/100 km (26.6 mpg).

Light trucks and vans

In 1982, the 45 light trucks and two vans for which fuel efficiency records were available, had a median age of 5 years (the average age was 6) and their average fuel efficiency was 20.3 L/100 km (13.9 mpg) (Table 5.10a). Those older than the median age averaged 23.1 L/100 km (12.2 mpg), those newer than the median age averaged 18.8 L/100 km (15.0 mpg). Figure 5.12a shows the variation of fuel efficiency with age.

The range of efficiencies for these light trucks and vans was 38.5 to 7.6 L/100 km (7.3 to 37.1 mpg) (Table 5.11a). The median efficiency of these vehicles was 22.3 L/100 km (13.5 mpg). Those less efficient than the median averaged 25.9 L/100 km (10.9 mpg), those more efficient than the median averaged 16.4 L/100 km (17.2 mpg).

In 1983, the 44 light trucks and one van for which fuel efficiency records were available, had a median age of 6 years (the average age was 7) and their average fuel efficiency was 20.3 L/100 km (13.9 mpg) (Table 5.10b). Those older than the median age averaged 23.4 L/100 km (12.1 mpg), those newer than the median age averaged 18.6 L/100 km

Table 5.7a

Gasoline, Heavy Trucks, 1982

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100km)	DISTANCE DRIVEN 1982 (km/a)
1	Truck, 3 ton, Ford, 1970	1057	63.0	1678
1	Truck, 3 ton, Ford, 1973	2130	63.0	3381
2	Truck, Reo, 1948	491	47.0	1045
2	Truck, 4 ton, Chev, 1965	1688	70.0	2411
2	Truck, 3 ton, Dodge, 1975	2763	59.2	4667
3	Truck, 4 ton, Ford, 1964	1261	87.4	1443
5	Truck, 1.5 ton, IHC, 1952	111	39.4	282
5	Truck, 3 ton, Dodge 600, 1974	2423	73.0	3319
6	Truck, 1 ton, Chev, 1958	86	13.0	662
6	Truck, 3 ton, Chevrolet, 1960	674	41.8	1612
6	Truck, 3 ton, Ford, 1964	1998	36.7	5444
6	Truck, 3 ton, GMC, 1976	1658	52.1	3182
7	Truck, tandem, GMC, 1974	837	41.0	2041
7	Truck, 3 ton, GMC, 1978	1711	50.5	3388
8	Truck, 3 ton, Ford, 1962	811	56.0	1448
8	Truck, 1 ton, IHC 1310, 1970	762	54.1	1409
8	Truck, 1 ton, Chevrolet, 1978	1698	28.7	5916
8	Truck, tandem, IHC, 1978	2890	40.0	7225
9	Truck, 1 ton, IHC, 1960	695	38.3	1815
11	Truck, 2 ton, IHC, 1966	1313	33.8	3885
12	Truck, 1.5 ton, GMC, 1954	411	35.3	1164
12	Truck, 3 ton, GMC, 1964	986	43.0	2293
13	Truck, 1 ton, GMC, 1966	321	26.0	1235
13	Truck, 3 ton, IHC, 1970	2712	40.0	6780
14	Truck, 3 ton, Chev, 1976	2002	35.3	5671
16	Truck, 2.5 ton, GMC, 1956	343	69.4	494
16	Truck, 3 ton, GMC, 1975	1703	61.8	2756
17	Truck, Ford, 1970	187	77.4	242
17	Truck, 3 ton, Ford 600, 1979	1336	43.3	3085
18	Truck, 3 ton, GMC 6500, 1974	2074	25.9	8008
18	Truck, 3 ton, GMC 6500, 1981	7610	38.0	20026
19	Truck, 2 ton, Chev, 1977	541	44.6	1213
20	Truck, 1 ton, GMC, 1949	353	35.0	1009
20	Truck, 1 ton, IHC, 1950	70	35.0	200
20	Truck, 2 ton, Chev, 1960	258	47.0	549
20	Truck, 3 ton, Chev, 1981	2059	47.0	4381
21	Truck, 3 ton, IHC 1600, 1973	2667	55.3	4823
21	Truck, 3 ton, Chev 60, 1980	863	54.4	1586
	38	53553	44.0	121768

Table 5.7b

Gasoline, Heavy Trucks, 1983

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100km)	DISTANCE DRIVEN 1983 (km/a)
1	Truck, 3 ton, Ford, 1970	1355	63.0	2151
1	Truck, 3 ton, Ford, 1973	2111	63.0	3351
2	Truck, Reo, 1948	383	47.0	815
2	Truck, 3 ton, Dodge, 1975	2596	65.9	3939
2	Truck, 4 ton, Chev, 1965	311	70.0	444
3	Truck, 4 ton, Ford, 1964	908	77.5	1172
5	Truck, 1.5 ton, IHC, 1952	159	50.4	315
5	Truck, 3 ton, Dodge 600, 1974	2063	69.7	2960
6	Truck, 1 ton, Chev, 1958	180	13.0	1385
6	Truck, 3 ton, GMC, 1976	1552	52.1	2979
6	Truck, 3 ton, Ford, 1964	1289	37.8	3410
6	Truck, 3 ton, Chevrolet, 1960	1219	35.7	3415
7	Truck, tandem, GMC, 1974	961	41.0	2344
7	Truck, 3 ton, GMC, 1978	2965	42.3	7009
9	Truck, 1 ton, IHC, 1960	837	36.0	2325
11	Truck, 2 ton, IHC, 1966	498	33.0	1509
12	Truck, 1.5 ton, GMC, 1954	191	35.3	541
12	Truck, 3 ton, GMC, 1964	570	34.6	1647
13	Truck, 1 ton, GMC, 1966	411	43.2	951
13	Truck, 3 ton, IHC, 1970	2083	65.6	3175
14	Truck, 2 ton, Chev, 1976	231	25.0	924
14	Truck, 3 ton, Chev, 1976	2328	43.1	5401
16	Truck, 2.5 ton, GMC, 1956	850	42.7	1991
16	Truck, 3 ton, GMC, 1975	2545	41.1	6192
17	Truck, Ford, 1970	150	43.2	347
17	Truck, 3 ton, Ford 600, 1979	1438	40.2	3577
18	Truck, 3 ton, GMC 6500, 1981	5669	38.0	14918
18	Truck, 3 ton, GMC 6500, 1974	2069	25.9	7988
19	Truck, 2 ton, Chev, 1977	626	44.6	1404
20	Truck, 1 ton, GMC, 1949	651	35.0	1860
20	Truck, 2 ton, Chev, 1960	561	47.0	1194
20	Truck, 3 ton, Chev, 1981	3431	47.0	7300
21	Truck, 3 ton, Chev 60, 1980	123	54.4	226
21	Truck, 3 ton, IHC 1600, 1973	3566	51.6	6911
22	Truck, 3 ton, IHC, 1968	1500	58.1	2582
22	Truck, 3 ton, Dodge, 1975	1500	48.7	3080
23	Truck, 2.5 ton, GMC, 1969	945	32.6	2899
	37	50825	44.3	114632

Table 5.8a

Cars - Sorted by Model Year, 1982

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1982 (km/a)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
5	Car, Dodge Dart, 1967	1344	12.7	10583	c	67	g	16			
9	Car, Ford Fairlane, 1968	156	14.0	1114	c	68	g	15			
6	Car, Chrysler, 1969	1693	22.2	7626	c	69	g	14			
6	Car, Datsun, 1970	1120	11.1	10090	c	70	g	13			
9	Car, Plymouth, 1970	6	14.0	43	c	70	g	13			
2	Car, Toyota, 1971	661	11.3	5850	c	71	g	12			
2	Car, Dodge Dart, 1971	1810	15.9	11384	c	71	g	12			
20	Car, Chrysler, 1972	7792	14.0	55657	c	72	g	11			
7	Car, Chevrolet 1974	3319	21.4	15509	c	74	g	9			
12	Car, Datsun, 1974	1464	10.2	14353	c	74	g	9			
2	Car, Buick Skylark, 1975	1078	15.7	6866	c	75	g	8			
2	Car, Dodge Coronet, 1975	1528	15.7	9732	c	75	g	8			
14	Car, Mercury, 1975	1196	17.7	6757	c	75	g	8			
1	Car, Plymouth, 1976	1546	18.1	8541	c	76	g	7			
8	Car, Ford Meteor, 1976	1097	19.5	5626	c	76	g	7		older 18	
19	Car, Toyota, 1976	819	10.4	7875	c	76	g	7	27757	14.6	190572
11	Car, Ford Pinto, 1978	1128	8.7	12966	c	78	g	5	median		
12	Car, Chevrolet Malibu, 1978	3336	13.9	24000	c	78	g	5	median		
15	Car, Mercury, 1978	3500	16.6	21084	c	78	g	5	47682	13.2	361853
1	Car, Oldsmobile, 1979	2514	11.7	21487	c	79	d	4		newer 18	
5	Car, Oldsmobile, 1979	2691	14.0	19221	c	79	g	4			
7	Car, Pontiac, 1979	2768	14.2	19493	c	79	g	4			
8	Car, Ford LTD, 1979	2416	20.0	12080	c	79	g	4			
8	Car, Lincoln, 1979	3187	17.8	17904	c	79	g	4			
10	Car, Dodge, 1979	2793	14.2	19669	c	79	g	4			
17	Car, Cordoba, 1979	3135	12.8	24492	c	79	g	4			
7	Car, Buick, 1980	3357	16.3	20595	c	80	g	3			
15	Car, Mercury, 1980	2300	12.8	17969	c	80	g	3			
16	Car, Citation, 1980	2595	11.8	21992	c	80	g	3			
2	Car, Dodge K-car, 1981	2964	9.8	30245	c	81	g	2			
3	Car, Mercury, 1981	2989	12.9	23171	c	81	g	2			
13	Car, Pontiac, 1981	85	9.4	904	c	81	d	2			
14	Car, Mercury Lynx, 1981	1380	8.5	16235	c	81	g	2			
18	Car, Oldsmobile, 1981	3530	10.0	35300	c	81	g	2			
14	Car, Oldsmobile, 1982	1437	11.3	12717	c	82	g	1			
8	Car, Chevrolet Z-28, 1983	705	21.4	3294	c	83	g	0			
	36	75439	13.7	552425				6			

Table 5.8b

Cars - Sorted by Model Year, 1983

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1983 (km/a)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
23	Car, Ford Falcon, 1960	527	12.6	4183	c	60	g	24			
5	Car, Dodge Dart, 1967	912	15.0	6080	c	67	g	17			
6	Car, Chrysler, 1969	914	19.7	4640	c	69	g	15			
13	Car, Chevelle, 1969	1372	27.1	5063	c	69	g	15			
6	Car, Datsun, 1970	935	9.2	10163	c	70	g	14			
2	Car, Toyota, 1971	469	11.3	4150	c	71	g	13			
2	Car, Dodge Dart, 1971	2410	19.6	12296	c	71	g	13			
20	Car, Chrysler, 1972	1882	14.0	13443	c	72	g	12			
7	Car, Chevrolet 1974	2565	20.1	12761	c	74	g	10			
2	Car, Buick Skylark, 1975	1178	15.3	7699	c	75	g	9			
2	Car, Dodge Coronet, 1975	1132	15.7	7210	c	75	g	9			
5	Car, Valiant, 1975	1719	15.7	10949	c	75	g	9			
14	Car, Mercury, 1975	1700	22.0	7727	c	75	g	9			
1	Car, Plymouth, 1976	941	17.9	5257	c	76	g	8			
5	Car, Nova, 1976	1630	13.4	12164	c	76	g	8			
19	Car, Toyota, 1976	2040	10.4	19615	c	76	g	8		older 17	
23	Car, Mercury Monarch, 1977	2203	11.4	19325	c	77	g	7	24529	15.1	162725
11	Car, Ford Pinto, 1978	1705	9.5	17947	c	78	g	6	median		
12	Car, Chevrolet Malibu, 1978	3748	18.9	19831	c	78	g	6	55285	12.9	429137
15	Car, Mercury, 1978	3650	16.6	21988	c	78	g	6		newer 17	
1	Car, Oldsmobile, 1979	2611	11.7	22316	c	79	d	5			
5	Car, Oldsmobile, 1979	3013	15.9	18950	c	79	g	5			
7	Car, Pontiac, 1979	2343	16.5	14200	c	79	g	5			
10	Car, Dodge, 1979	4196	19.2	21854	c	79	g	5			
17	Car, Cordoba, 1979	2711	12.9	21016	c	79	g	5			
7	Car, Buick, 1980	4211	16.8	25065	c	80	g	4			
15	Car, Mercury, 1980	2050	12.8	16016	c	80	g	4			
16	Car, Citation, 1980	2649	11.8	22449	c	80	g	4			
22	Car, Chev Wagon, 1980	4100	14.6	28082	c	80	d	4			
2	Car, Dodge K-car, 1981	2621	9.1	28802	c	81	g	3			
3	Car, Mercury, 1981	3843	13.5	28467	c	81	g	3			
13	Car, Pontiac, 1981	3510	8.7	40345	c	81	d	3			
18	Car, Oldsmobile, 1981	5961	10.0	59610	c	81	g	3			
6	Car, Ford Escort, 1982	1568	8.7	18023	c	82	g	2			
14	Car, Oldsmobile, 1982	2500	11.3	22124	c	82	g	2			
	35	81519	13.4	609810				7.9			

Figure 5.11a

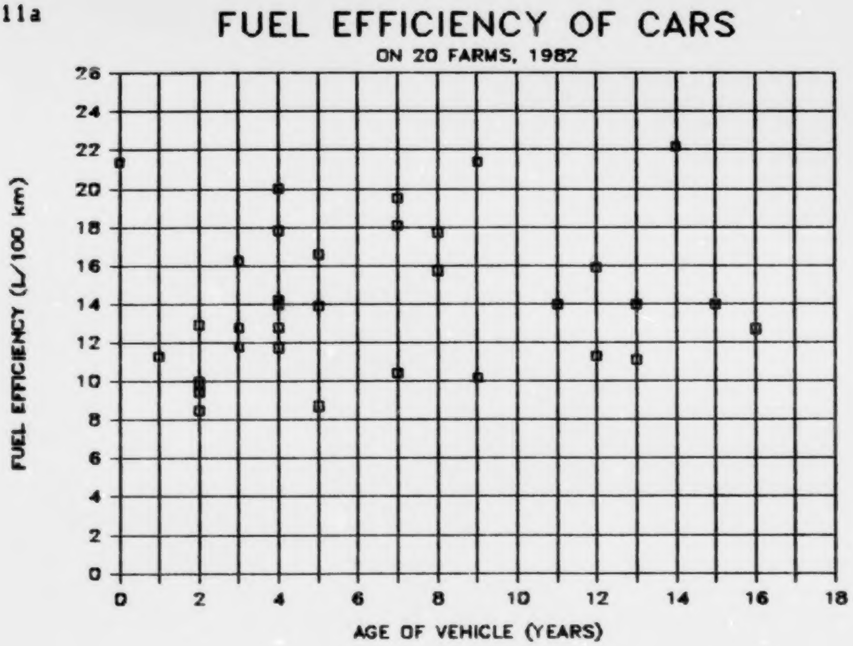


Figure 5.11b

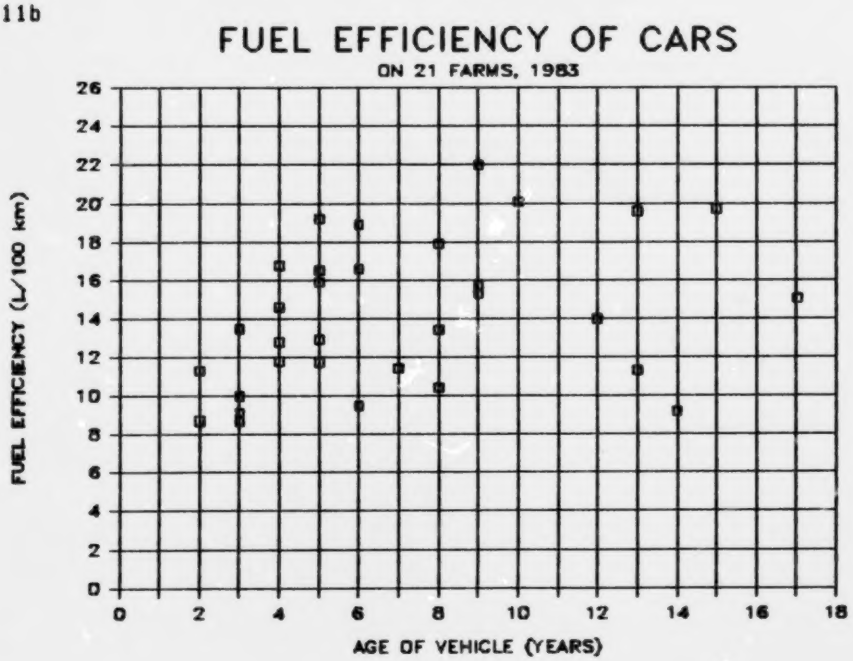


Table 5.9a

Cars - Sorted by Fuel Efficiency, 1982

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1982 (km/a)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
6	Car, Chrysler, 1969	1693	22.2	7626	c	69	g	14			
7	Car, Chevrolet 1974	3319	21.4	15509	c	74	g	9			
8	Car, Chevrolet Z-28, 1983	705	21.4	3294	c	83	g	0			
8	Car, Ford LTD, 1979	2416	20.0	12080	c	79	g	4			
8	Car, Ford Meteor, 1976	1097	19.5	5626	c	76	g	7			
1	Car, Plymouth, 1976	1546	18.1	8541	c	76	g	7			
8	Car, Lincoln, 1979	3187	17.8	17904	c	79	g	4			
14	Car, Mercury, 1975	1196	17.7	6757	c	75	g	8			
15	Car, Mercury, 1978	3500	16.6	21084	c	78	g	5			
7	Car, Buick, 1980	3357	16.3	20595	c	80	g	3			
2	Car, Dodge Dart, 1971	1810	15.9	11384	c	71	g	12			
2	Car, Buick Skylark, 1975	1078	15.7	6866	c	75	g	8			
2	Car, Dodge Coronet, 1975	1528	15.7	9732	c	75	g	8			
7	Car, Pontiac, 1979	2768	14.2	19493	c	79	g	4			
10	Car, Dodge, 1979	2793	14.2	19669	c	79	g	4			
9	Car, Plymouth, 1970	6	14.0	43	c	70	g	13		less efficient 18	
20	Car, Chrysler, 1972	7792	14.0	55657	c	72	g	11	42482	16.3	261083
5	Car, Oldsmobile, 1979	2691	14.0	19221	c	79	g	4	median		
9	Car, Ford Fairlane, 1968	156	14.0	1114	c	68	g	15	median		
12	Car, Chevrolet Malibu, 1978	3336	13.9	24000	c	78	g	5	32957	11.3	291342
3	Car, Mercury, 1981	2989	12.9	23171	c	81	g	2		more efficient 18	
15	Car, Mercury, 1980	2300	12.8	17969	c	80	g	3			
17	Car, Cordoba, 1979	3135	12.8	24492	c	79	g	4			
5	Car, Dodge Dart, 1967	1344	12.7	10583	c	67	g	16			
16	Car, Citation, 1980	2595	11.8	21992	c	80	g	3			
1	Car, Oldsmobile, 1979	2514	11.7	21487	c	79	d	4			
14	Car, Oldsmobile, 1982	1437	11.3	12717	c	82	g	1			
2	Car, Toyota, 1971	661	11.3	5850	c	71	g	12			
6	Car, Datsun, 1970	1120	11.1	10090	c	70	g	13			
19	Car, Toyota, 1976	819	10.4	7875	c	76	g	7			
12	Car, Datsun, 1974	1464	10.2	14353	c	74	g	9			
18	Car, Oldsmobile, 1981	3530	10.0	35300	c	81	g	2			
2	Car, Dodge K-car, 1981	2964	9.8	30245	c	81	g	2			
13	Car, Pontiac, 1981	85	9.4	904	c	81	d	2			
11	Car, Ford Pinto, 1978	1128	8.7	12966	c	78	g	5			
14	Car, Mercury Lynx, 1981	1380	8.5	16235	c	81	g	2			
	36	75439	13.7	552425							

Table 5.9b

Cars - Sorted by Fuel Efficiency, 1983

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1983 (km/a)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
13	Car, Chevelle, 1969	1372	27.1	5063	c	69	g	15			
14	Car, Mercury, 1975	1700	22.0	7727	c	75	g	9			
7	Car, Chevrolet 1974	2565	20.1	12761	c	74	g	10			
6	Car, Chrysler, 1969	914	19.7	4640	c	69	g	15			
2	Car, Dodge Dart, 1971	2410	19.6	12296	c	71	g	13			
10	Car, Dodge, 1979	4196	19.2	21854	c	79	g	5			
12	Car, Chevrolet Malibu, 1978	3748	18.9	19831	c	78	g	6			
1	Car, Plymouth, 1976	941	17.9	5257	c	76	g	8			
7	Car, Buick, 1980	4211	16.8	25065	c	80	g	4			
15	Car, Mercury, 1978	3650	16.6	21988	c	78	g	6			
7	Car, Pontiac, 1979	2343	16.5	14200	c	79	g	5			
5	Car, Oldsmobile, 1979	3013	15.9	18950	c	79	g	5			
2	Car, Dodge Coronet, 1975	1132	15.7	7210	c	75	g	9			
5	Car, Valiant, 1975	1719	15.7	10949	c	75	g	9			
2	Car, Buick Skylark, 1975	1178	15.3	7699	c	75	g	9			
5	Car, Dodge Dart, 1967	912	15.0	6080	c	67	g	17			
22	Car, Chev Wagon, 1980	4100	14.6	28082	c	80	d	4		less efficient 17	
20	Car, Chrysler, 1972	1882	14.0	13443	c	72	g	12	41986	17.3	243095
3	Car, Mercury, 1981	3843	13.5	28467	c	81	g	3	median		
5	Car, Nova, 1976	1630	13.4	12164	c	76	g	8	35690	10.6	338248
17	Car, Cordoba, 1979	2711	12.9	21016	c	79	g	5		more efficient 17	
15	Car, Mercury, 1980	2050	12.8	16016	c	80	g	4			
23	Car, Ford Falcon, 1960	527	12.6	4183	c	60	g	24			
16	Car, Citation, 1980	2649	11.8	22449	c	80	g	4			
1	Car, Oldsmobile, 1979	2611	11.7	22316	c	79	d	5			
23	Car, Mercury Monarch, 1977	2203	11.4	19325	c	77	g	7			
2	Car, Toyota, 1971	469	11.3	4150	c	71	g	13			
14	Car, Oldsmobile, 1982	2500	11.3	22124	c	82	g	2			
19	Car, Toyota, 1976	2040	10.4	19615	c	76	g	8			
18	Car, Oldsmobile, 1981	5961	10.0	59610	c	81	g	3			
11	Car, Ford Pinto, 1978	1705	9.5	17947	c	78	g	6			
6	Car, Datsun, 1970	935	9.2	10163	c	70	g	14			
2	Car, Dodge K-car, 1981	2621	9.1	28802	c	81	g	3			
6	Car, Ford Escort, 1982	1568	8.7	18023	c	82	g	2			
13	Car, Pontiac, 1981	3510	8.7	40345	c	81	d	3			
	35	81519	13.4	609810							

Table 5.10a

Light Trucks & Vans - Sorted by Model Year, 1982

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1982 (km)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
20	Truck, 1/2 ton, Dodge, 1964	1328	20.7	6415	lt	64	g	19			
16	Truck, 1/2 ton, Chev, 1966	313	18.7	1674	lt	66	g	17			
20	Truck, 1/2 ton, Ford, 1966	60	20.0	300	lt	66	g	17			
9	Truck, 1/2 ton, Fargo, 1968	350	26.9	1301	lt	68	g	15			
6	Truck, 1/2 ton, Chev, 1969	1267	22.5	5631	lt	69	g	14			
6	Truck, 1/2 ton, Chev, 1970	1332	15.9	8377	lt	70	g	13			
12	Truck, 1/2 ton, GMC, 1971	2981	24.9	11972	lt	71	g	12			
13	Truck, Mazda 1600, 1971	611	8.0	7638	lt	71	g	12			
8	Truck, 1/2 ton, Chev, 1972	707	23.5	3009	lt	72	g	11			
15	Truck, 1/2 ton, Ford, 1973	3745	23.5	15936	lt	73	g	10			
7	Truck, 1/2 ton, GMC, 1974	1670	25.6	6523	lt	74	g	9			
5	Truck, 1/2 ton, Ford, 1974	2015	26.0	7750	lt	74	g	9			
15	Truck, 3/4 ton, Ford, 1974	7051	26.1	27015	lt	74	g	9			
3	Truck, 3/4 ton, Chev, 1975	6395	37.9	16873	lt	75	g	8			
18	Truck, 1/2 ton, Chev, 1975	900	24.9	3614	lt	75	g	8			
9	Truck, 1/2 ton, GMC, 1976	3619	16.2	22340	lt	76	g	7			
20	Truck, 1/2 ton, GMC, 1976	969	28.0	3461	lt	76	g	7			
1	Truck, 1/2 ton, Ford, 1976	2610	25.5	10235	lt	76	g	7			
19	Truck, Toyota, 1976	2146	27.4	7832	lt	76	g	7			
10	Truck, 1/2 ton, Dodge, 1976	4856	21.1	23014	lt	76	g	7			
21	Truck, 3/4 ton, Ford, 1976	353	25.1	1406	lt	76	g	7			
11	Truck, 1/2 ton, GMC, 1978	824	12.4	6645	lt	78	g	5		older 23	
18	Truck, 1/2 ton, Chev, 1978	6800	22.8	29825	lt	78	g	5	52902	23.1	228787
21	Truck, 1/2 ton, F150, 1978	4890	20.2	24208	lt	78	g	5	median		
7	Truck, 1/2 ton, GMC, 1978	4305	16.0	26906	lt	78	d	5	75388	18.8	401764
8	Van, Ford 150, 1978	1632	38.5	4239	v	78	g	5		newer 23	
13	Truck, 1/2 ton, Chev, 1978	3002	22.0	13645	lt	78	g	5			
8	Truck, 1/2 ton, Chev, 1978	1106	33.6	3292	lt	78	g	5			
2	Truck 3/4 ton, Dodge, 1979	5462	22.8	23956	lt	79	g	4			
17	Truck, 1/2 ton, Ford 100, 1979	2219	20.2	10985	lt	79	g	4			
7	Truck, 1/2 ton, GMC, 1979	8558	22.3	38377	lt	79	g	4			
18	Truck, 1/2 ton, Chev, 1980	4900	24.0	20417	lt	80	g	3			
21	Truck, 4x4, Chev, 1980	2316	27.8	8331	lt	80	g	3			
3	Truck, 1/2 ton, Ford, 1980	260	23.5	1106	lt	80	g	3			
8	Truck, 1/2 ton, Ford 1980	7308	24.5	29829	lt	80	g	3			
19	Truck, 1/2 ton, Ford, 1980	4058	18.6	21817	lt	80	d	3			
6	Truck, 3/4 ton, Ford, 1980	8371	21.9	38224	lt	80	g	3			
8	Truck, 1/2 ton, Volksw, 1980	2133	7.6	28066	lt	80	g	3			
16	Truck, Ford F-150, 1981	926	30.0	3087	lt	81	g	2			
2	Van, Dodge, 1981	3444	20.8	16558	v	81	g	2			
7	Truck, 1/2 ton, GMC, 1982	4318	16.8	25702	lt	82	g	1			
6	Truck, 1/2 ton, Dodge, 1982	1303	22.0	5923	lt	82	g	1			
14	Truck, 1/2 ton, Chev S15, 1982	2076	9.9	20970	lt	82	g	1			
8	Truck,1/2 ton, Chev S10, 1982	2518	12.1	20810	lt	82	g	1			
14	Truck, 1/2 ton, Chev, 1982	3535	13.6	25993	lt	82	g	1			
15	Truck, Ford 250, 1983	460	14.8	3108	lt	83	g	0			
15	Truck, Ford Ranger, 1983	1178	11.3	10425	lt	83	g	0			
		47 133180	20.3	654760				6			

Table 5.10b

Light Trucks & Vans - Sorted by Model Year, 1983

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1983 (km)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
20	Truck, 1/2 ton, Dodge, 1964	937	20.7	4527	lt	64	g	20			
16	Truck, 1/2 ton, Chev, 1966	352	20.8	1692	lt	66	g	18			
9	Truck, 1/2 ton, Fargo, 1968	713	20.8	3428	lt	68	g	16			
6	Truck, 1/2 ton, Chev, 1969	690	24.4	2828	lt	69	g	15			
6	Truck, 1/2 ton, Chev, 1970	1162	19.7	5898	lt	70	g	14			
22	Truck, 1/2 ton, GMC, 1970	2000	25.1	7968	lt	70	g	14			
12	Truck, 1/2 ton, GMC, 1971	2988	20.3	14719	lt	71	g	13			
13	Truck, Mazda 1600, 1971	1244	15.2	8184	lt	71	g	13			
15	Truck, 3/4 ton, Ford, 1973	1002	25.2	3976	lt	73	g	11			
22	Truck, 1/2 ton, GMC, 1973	1082	24.5	4416	lt	73	g	11			
5	Truck, 1/2 ton, Ford, 1974	2209	26.3	8399	lt	74	g	10			
7	Truck, 1/2 ton, GMC, 1974	1871	31.6	5921	lt	74	g	10			
15	Truck, 3/4 ton, Ford, 1974	2692	26.3	10236	lt	74	g	10			
3	Truck, 3/4 ton, Chev, 1975	7939	38.0	20892	lt	75	g	9			
18	Truck, 1/2 ton, Chev, 1975	5590	24.9	22450	lt	75	g	9			
1	Truck, 1/2 ton, Ford, 1976	3131	21.7	14429	lt	76	g	8			
9	Truck, 1/2 ton, GMC, 1976	3555	15.8	22500	lt	76	g	8			
10	Truck, 1/2 ton, Dodge, 1976	4920	20.8	23654	lt	76	g	8			
13	Truck, 1/2 ton, Chev, 1976	5436	20.9	26010	lt	76	g	8			
19	Truck, Toyota, 1976	1713	26.2	6538	lt	76	g	8			
20	Truck, 1/2 ton, GMC, 1976	1532	28.0	5471	lt	76	g	8		older 22	
20	Truck, 1/2 ton, Dodge, 1977	2043	19.5	10477	lt	77	g	7	54801	23.4	234613
7	Truck, 1/2 ton, GMC, 1978	3605	17.6	20483	lt	78	g	6	median		
11	Truck, 1/2 ton, GMC, 1978	697	11.3	6168	lt	78	d	6	77065	18.6	413308
13	Truck, 1/2 ton, Chev, 1978	7154	21.1	33905	lt	78	g	6		newer 22	
18	Truck, 1/2 ton, Chev, 1978	7810	22.8	34254	lt	78	g	6			
21	Truck, 1/2 ton, F150, 1978	4399	20.2	21777	lt	78	g	6			
2	Truck 3/4 ton, Dodge, 1979	5638	28.2	19993	lt	79	g	5			
7	Truck, 1/2 ton, GMC, 1979	1968	22.3	8825	lt	79	g	5			
17	Truck, 1/2 ton, F100, 1979	1617	16.6	9741	lt	79	g	5			
3	Truck, 1/2 ton, Ford, 1980	46	23.5	196	lt	80	g	4			
6	Truck, 3/4 ton, Ford, 1980	6681	24.5	27269	lt	80	g	4			
19	Truck, 1/2 ton, Ford, 1980	2997	16.1	18615	lt	80	g	4			
21	Truck, 4x4, Chev, 1980	3810	23.0	16565	lt	80	g	4			
2	Van, Dodge, 1981	4197	17.9	23447	v	81	g	3			
16	Truck, Ford F-150, 1981	1421	18.7	7599	lt	81	g	3			
6	Truck, 1/2 ton, Dodge, 1982	2183	19.3	11311	lt	82	g	2			
7	Truck, 1/2 ton, GMC, 1982	4282	16.8	25488	lt	82	g	2			
14	Truck, 1/2 ton, Chev S15, 1982	2262	9.9	22848	lt	82	g	2			
14	Truck, 1/2 ton, Chev, 1982	3651	13.8	26457	lt	82	g	2			
7	Truck, 4x4, GMC, 1983	5458	17.8	30663	lt	83	g	1			
15	Truck, Ford Ranger, 1983	3050	11.3	26991	lt	83	g	1			
15	Truck, 1/2 ton, Ford, 1983	1589	24.0	6621	lt	83	g	1			
15	Truck, Ford 250, 1983	5660	17.6	32159	lt	83	g	1			
7	Truck, 1/2 ton, GMC, 1984	495	20.5	2415	lt	84	g	0			
	45	135471	20.3	668404				7.3			

Figure 5.12a

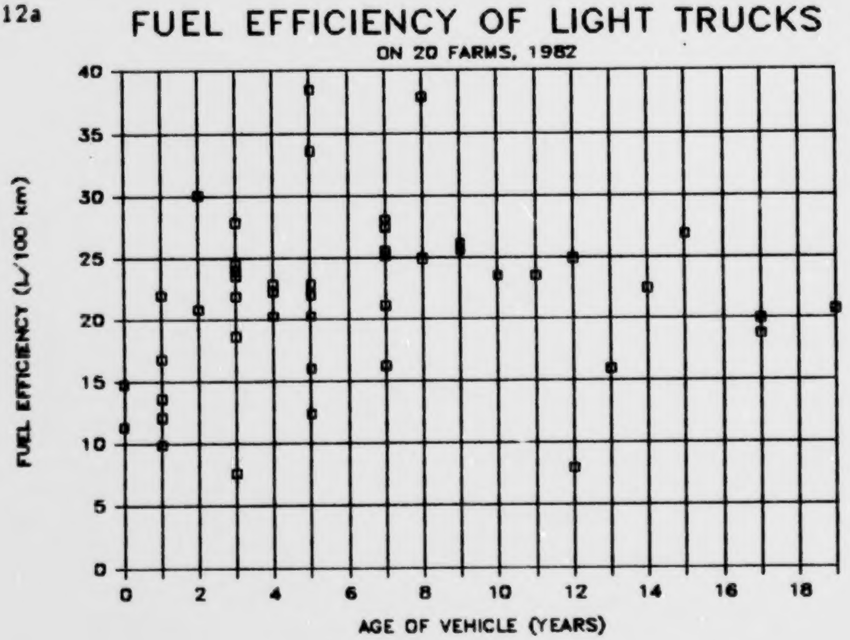


Figure 5.12b

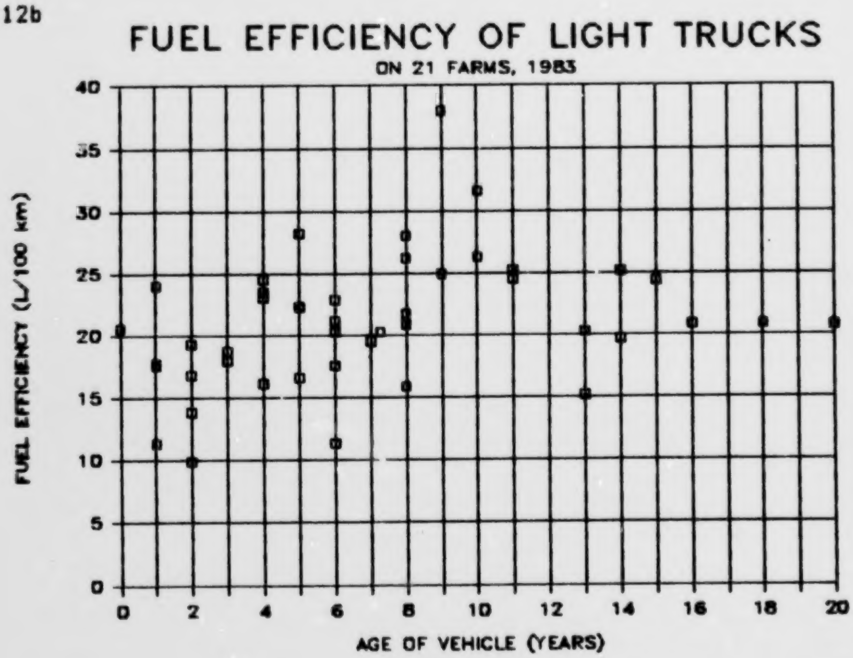


Table 5.11a

Light Trucks & Vans - Sorted by Fuel Efficiency, 1982

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1982 (km)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
8	Van, Ford 150, 1978	1632	38.5	4239	v	78	g	5			
3	Truck, 3/4 ton, Chev, 1975	6395	37.9	16873	lt	75	g	8			
8	Truck, 1/2 ton, Chev, 1978	1106	33.6	3292	lt	78	g	5			
16	Truck, Ford F-150, 1981	926	30.0	3087	lt	81	g	2			
20	Truck, 1/2 ton, GMC, 1976	969	28.0	3461	lt	76	g	7			
21	Truck, 4x4, Chev, 1980	2316	27.8	8331	lt	80	g	3			
19	Truck, Toyota, 1976	2146	27.4	7832	lt	76	g	7			
9	Truck, 1/2 ton, Fargo, 1968	350	26.9	1301	lt	68	g	15			
15	Truck, 3/4 ton, Ford, 1974	7051	26.1	27015	lt	74	g	9			
5	Truck, 1/2 ton, Ford, 1974	2015	26.0	7750	lt	74	g	9			
7	Truck, 1/2 ton, GMC, 1974	1670	25.6	6523	lt	74	g	9			
1	Truck, 1/2 ton, Ford, 1976	2610	25.5	10235	lt	76	g	7			
21	Truck, 3/4 ton, Ford, 1976	353	25.1	1406	lt	76	g	7			
12	Truck, 1/2 ton, GMC, 1971	2981	24.9	11972	lt	71	g	12			
18	Truck, 1/2 ton, Chev, 1975	900	24.9	3614	lt	75	g	8			
8	Truck, 1/2 ton, Ford 1980	7308	24.5	29829	lt	80	g	3			
18	Truck, 1/2 ton, Chev, 1980	4900	24.0	20417	lt	80	g	3			
8	Truck, 1/2 ton, Chev, 1972	707	23.5	3009	lt	72	g	11			
15	Truck, 1/2 ton, Ford, 1973	3745	23.5	15936	lt	73	g	10			
3	Truck, 1/2 ton, Ford, 1980	260	23.5	1106	lt	80	g	3			
2	Truck 3/4 ton, Dodge, 1979	5462	22.8	23956	lt	79	g	4			
18	Truck, 1/2 ton, Chev, 1978	6800	22.8	29825	lt	78	g	5		less efficient	23
6	Truck, 1/2 ton, Chev, 1969	1267	22.5	5631	lt	69	g	14	63869	25.9	246640
7	Truck, 1/2 ton, GMC, 1979	8558	22.3	38377	lt	79	g	4	median		
6	Truck, 1/2 ton, Dodge, 1982	1303	22.0	5923	lt	82	g	1	60753	16.4	369742
13	Truck, 1/2 ton, Chev, 1978	3002	22.0	13645	lt	78	g	5		more efficient	23
6	Truck, 3/4 ton, Ford, 1980	8371	21.9	38224	lt	80	g	3			
10	Truck, 1/2 ton, Dodge, 1976	4856	21.1	23014	lt	76	g	7			
2	Van, Dodge, 1981	3444	20.8	16558	v	81	g	2			
20	Truck, 1/2 ton, Dodge, 1964	1328	20.7	6415	lt	64	g	19			
21	Truck, 1/2 ton, F150, 1978	4890	20.2	24208	lt	78	g	5			
17	Truck, 1/2 ton, Ford 100, 1979	2219	20.2	10985	lt	79	g	4			
20	Truck, 1/2 ton, Ford, 1966	60	20.0	300	lt	66	g	17			
16	Truck, 1/2 ton, Chev, 1966	313	18.7	1674	lt	66	g	17			
19	Truck, 1/2 ton, Ford, 1980	4058	18.6	21817	lt	80	d	3			
7	Truck, 1/2 ton, GMC, 1982	4318	16.8	25702	lt	82	g	1			
9	Truck, 1/2 ton, GMC, 1976	3619	16.2	22340	lt	76	g	7			
7	Truck, 1/2 ton, GMC, 1978	4305	16.0	26906	lt	78	d	5			
6	Truck, 1/2 ton, Chev, 1970	1332	15.9	8377	lt	70	g	13			
15	Truck, Ford 250, 1983	460	14.8	3108	lt	83	g	0			
14	Truck, 1/2 ton, Chev, 1982	3535	13.6	25993	lt	82	g	1			
11	Truck, 1/2 ton, GMC, 1978	824	12.4	6645	lt	78	g	5			
8	Truck,1/2 ton, Chev S10, 1982	2518	12.1	20810	lt	82	g	1			
15	Truck, Ford Ranger, 1983	1178	11.3	10425	lt	83	g	0			
14	Truck, 1/2 ton, Chev S15, 1982	2076	9.9	20970	lt	82	g	1			
13	Truck, Mazda 1600, 1971	611	8.0	7638	lt	71	g	12			
8	Truck, 1/2 ton, Volksw, 1980	2133	7.6	28066	lt	80	g	3			
	47	133180	20.3	654760				6			

Table 5.11b

Light Trucks & Vans - Sorted by Fuel Efficiency, 1983

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1983 (km)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
3	Truck, 3/4 ton, Chev, 1975	7939	38.0	20892	lt	75	g	9			
7	Truck, 1/2 ton, GMC, 1974	1871	31.6	5921	lt	74	g	10			
2	Truck 3/4 ton, Dodge, 1979	5638	28.2	19993	lt	79	g	5			
20	Truck, 1/2 ton, GMC, 1976	1532	28.0	5471	lt	76	g	8			
5	Truck, 1/2 ton, Ford, 1974	2209	26.3	8399	lt	74	g	10			
15	Truck, 3/4 ton, Ford, 1974	2692	26.3	10236	lt	74	g	10			
19	Truck, Toyota, 1976	1713	26.2	6538	lt	76	g	8			
15	Truck, 3/4 ton, Ford, 1973	1002	25.2	3976	lt	73	g	11			
22	Truck, 1/2 ton, GMC, 1970	2000	25.1	7968	lt	70	g	14			
18	Truck, 1/2 ton, Chev, 1975	5590	24.9	22450	lt	75	g	9			
6	Truck, 3/4 ton, Ford, 1980	6681	24.5	27269	lt	80	g	4			
22	Truck, 1/2 ton, GMC, 1973	1082	24.5	4416	lt	73	g	11			
6	Truck, 1/2 ton, Chev, 1969	690	24.4	2828	lt	69	g	15			
15	Truck, 1/2 ton, Ford, 1983	1589	24.0	6621	lt	83	g	1			
3	Truck, 1/2 ton, Ford, 1980	46	23.5	196	lt	80	g	4			
21	Truck, 4x4, Chev, 1980	3810	23.0	16565	lt	80	g	4			
18	Truck, 1/2 ton, Chev, 1978	7810	22.8	34254	lt	78	g	6			
7	Truck, 1/2 ton, GMC, 1979	1968	22.3	8825	lt	79	g	5			
1	Truck, 1/2 ton, Ford, 1976	3131	21.7	14429	lt	76	g	8			
13	Truck, 1/2 ton, Chev, 1978	7154	21.1	33905	lt	78	g	6			
13	Truck, 1/2 ton, Chev, 1976	5436	20.9	26010	lt	76	g	8		less efficient	22
9	Truck, 1/2 ton, Fargo, 1968	713	20.8	3428	lt	68	g	16	72296	24.9	290591
10	Truck, 1/2 ton, Dodge, 1976	4920	20.8	23654	lt	76	g	8	median		
16	Truck, 1/2 ton, Chev, 1966	352	20.8	1692	lt	66	g	18	58255	16.4	354160
20	Truck, 1/2 ton, Dodge, 1964	937	20.7	4527	lt	64	g	20		more efficient	22
7	Truck, 1/2 ton, GMC, 1984	495	20.5	2415	lt	84	g	0			
12	Truck, 1/2 ton, GMC, 1971	2988	20.3	14719	lt	71	g	13			
21	Truck, 1/2 ton, F150, 1978	4399	20.2	21777	lt	78	g	6			
6	Truck, 1/2 ton, Chev, 1970	1162	19.7	5898	lt	70	g	14			
20	Truck, 1/2 ton, Dodge, 1977	2043	19.5	10477	lt	77	g	7			
6	Truck, 1/2 ton, Dodge, 1982	2183	19.3	11311	lt	82	g	2			
16	Truck, Ford F-150, 1981	1421	18.7	7599	lt	81	g	3			
2	Van, Dodge, 1981	4197	17.9	23447	v	81	g	3			
7	Truck, 4x4, GMC, 1983	5458	17.8	30663	lt	83	g	1			
7	Truck, 1/2 ton, GMC, 1978	3605	17.6	20483	lt	78	g	6			
15	Truck, Ford 250, 1983	5660	17.6	32159	lt	83	g	1			
7	Truck, 1/2 ton, GMC, 1982	4282	16.8	25488	lt	82	g	2			
17	Truck, 1/2 ton, F100, 1979	1617	16.6	9741	lt	79	g	5			
19	Truck, 1/2 ton, Ford, 1980	2997	16.1	18615	lt	80	g	4			
9	Truck, 1/2 ton, GMC, 1976	3555	15.8	22500	lt	76	g	8			
13	Truck, Mazda 1600, 1971	1244	15.2	8184	lt	71	g	13			
14	Truck, 1/2 ton, Chev, 1982	3651	13.8	26457	lt	82	g	2			
11	Truck, 1/2 ton, GMC, 1978	697	11.3	6168	lt	78	d	6			
15	Truck, Ford Ranger, 1983	3050	11.3	26991	lt	83	g	1			
14	Truck, 1/2 ton, Chev S15, 1982	2262	9.9	22848	lt	82	g	2			
	45	135471	20.3	668404				7.3			

(15.2 mpg). Figure 5.12b shows the variation of fuel efficiency with age.

The range of efficiencies for these light trucks and vans was 38.0 to 9.9 L/100 km (7.4 to 28.5 mpg) (Table 5.11b). The median efficiency of these vehicles was 20.8 L/100 km (13.9 mpg). Those less efficient than the median averaged 24.9 L/100 km (11.3 mpg), those more efficient than the median averaged 16.4 L/100 km (17.2 mpg).

Heavy trucks

In 1982, the 42 heavy trucks for which fuel efficiency records were available, had a median age of 13 years (the average age was 14) and their average fuel efficiency was 50.0 L/100 km (5.6 mpg) (Table 5.12a). Those older than the median age averaged 44.7 L/100 km (6.3 mpg), those newer than the median age averaged 51.5 L/100 km (5.5 mpg). Figure 5.13a shows the variation of fuel efficiency with age.

The range of efficiencies for these heavy trucks was 87.4 to 13.0 L/100 km (3.2 to 21.7 mpg) (Table 5.13a). The median efficiency of these vehicles was 47.0 L/100 km (6.0 mpg). Those less efficient than the median averaged 63.5 L/100 km (4.4 mpg), those more efficient than the median averaged 36.2 L/100 km (7.8 mpg).

The capacity of the 42 heavy trucks varied from 1 to 4 ton and possibly more (semis). The 19 3-ton trucks had an average efficiency of 44.8 L/100 km (6.3 mpg). Their median efficiency was 50.5 L/100 km (5.6 mpg). Trucks less efficient than the median averaged 59.9 L/100 km (4.7 mpg); trucks more efficient than the median averaged 37.4 L/100 km (7.5 mpg).

In 1983, the 39 heavy trucks for which fuel efficiency records were available, had a median age of 14 years (the average age was 15) and their average fuel efficiency was 46.3 L/100 km (6.1 mpg) (Table 5.12b). Those older than the median age averaged 45.4 L/100 km (6.2 mpg), those newer than the median age averaged 46.6 L/100 km (6.1 mpg). Figure 5.13b shows the variation of fuel efficiency with age.

The range of efficiencies for these heavy trucks was 77.5 to 25.0 L/100 km (3.6 to 11.3 mpg) (Table 5.13b). The median efficiency of these vehicles was 43.9 L/100 km (6.4 mpg). Those less efficient than the median averaged 56.2 L/100 km (5.0 mpg), those more efficient than the median averaged 37.5 L/100 km (7.5 mpg).

The capacity of the 39 heavy trucks varied from 1 to 4 ton and possibly more (semis). The 20 3-ton trucks had an average efficiency of 45.5 L/100 km (6.2 mpg). Their median efficiency was 47.9 L/100 km (5.9 mpg). Trucks less efficient than the median averaged 58.8 L/100 km (4.8 mpg); trucks more efficient than the median averaged 38.7 L/100 km (7.3 mpg).

Graphic comparisons of the ages and fuel efficiencies of the three groups of vehicles are shown in Figures 5.14a (5.14b), 5.15a (5.15b) and 5.16a (5.16b).

The combined distance travelled by all vehicles in each of the three groups was calculated by dividing the combined fuel used by each

Table 5.12a

Heavy Trucks - Sorted by Model Year, 1982

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1982 (km/a)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
2	Truck, Reo, 1948	491	47.0	1045	ht	48	g	35			
20	Truck, 1 ton, GMC, 1949	353	35.0	1009	ht	49	g	34			
20	Truck, 1 ton, IHC, 1950	70	35.0	200	1	50	g	33			
5	Truck, 1.5 ton, IHC, 1952	111	39.4	282	1.5	52	g	31			
12	Truck, 1.5 ton, GMC, 1954	411	35.3	1164	1.5	54	g	29			
16	Truck, 2.5 ton, GMC, 1956	343	69.4	494	2.5	56	g	27			
6	Truck, 1 ton, Chev, 1958	86	13.0	662	1	58	g	25			
20	Truck, 2 ton, Chev, 1960	258	47.0	549	2	60	g	23			
6	Truck, 3 ton, Chevrolet, 1960	674	41.8	1612	3	60	g	23			
9	Truck, 1 ton, IHC, 1960	695	38.3	1815	1	60	g	23			
8	Truck, 3 ton, Ford, 1962	811	56.0	1448	3	62	g	21			
12	Truck, 3 ton, GMC, 1964	986	43.0	2293	3	64	g	19			
6	Truck, 3 ton, Ford, 1964	1998	36.7	5444	3	64	g	19			
3	Truck, 4 ton, Ford, 1964	1261	87.4	1443	4	64	g	19			
2	Truck, 4 ton, Chev, 1965	1688	70.0	2411	4	65	g	18			
11	Truck, 2 ton, IHC, 1966	1313	33.8	3885	2	66	g	17			
13	Truck, 1 ton, GMC, 1966	321	26.0	1235	1	66	g	17			
1	Truck, 3 ton, Ford, 1970	1057	63.0	1678	3	70	g	13			
13	Truck, 3 ton, IHC, 1970	2712	40.0	6780	3	70	g	13		older 21	
8	Truck, 1 ton, IHC 1310, 1970	762	54.1	1409	1	70	g	13	16588	44.7	37098
17	Truck, Ford, 1970	187	77.4	242	ht	70	g	13	median		
15	Truck, tandem, Ford, 1971	6169	58.9	10474	ht	71	d	12	median		
1	Truck, 3 ton, Ford, 1973	2130	63.0	3381	3	73	g	10	64497	51.5	125212
21	Truck, 3 ton, IHC 1600, 1973	2667	55.3	4823	3	73	g	10		newer 21	
5	Truck, 3 ton, Dodge 600, 1974	2423	73.0	3319	3	74	g	9			
7	Truck, tandem, GMC, 1974	837	41.0	2041	ht	74	g	9			
18	Truck, 3 ton, GMC 6500, 1974	2074	25.9	8008	3	74	g	9			
16	Truck, 3 ton, GMC, 1975	1703	61.8	2756	3	75	g	8			
2	Truck, 3 ton, Dodge, 1975	2763	59.2	4667	3	75	g	8			
6	Truck, 3 ton, GMC, 1976	1658	52.1	3182	3	76	g	7			
14	Truck, 3 ton, Chev, 1976	2002	35.3	5671	3	76	g	7			
19	Truck, 2 ton, Chev, 1977	541	44.6	1213	2	77	g	6			
10	Truck, IHC 4070a, 1977	9084	77.4	11736	ht	77	d	6			
7	Truck, 3 ton, GMC, 1978	1711	50.5	3388	3	78	g	5			
8	Truck, tandem, IHC, 1978	2890	40.0	7225	ht	78	g	5			
8	Truck, 1 ton, Chevrolet, 1978	1698	28.7	5916	1	78	g	5			
17	Truck, 3 ton, Ford 600, 1979	1336	43.3	3085	3	79	g	4			
8	Truck, semi, Ford 9000, 1979	6287	71.9	8744	ht	79	d	4			
21	Truck, 3 ton, Chev 60, 1980	863	54.4	1586	3	80	g	3			
18	Truck, 3 ton, GMC 6500, 1981	7610	38.0	20026	3	81	g	2			
20	Truck, 3 ton, Chev, 1981	2059	47.0	4381	3	81	g	2			
8	Truck, tandem, IHC, 1981	5992	62.5	9587	ht	81	d	2			
	42	81085	50.0	162309				14			

VEHICLE TYPE:

ht = heavy truck (capacity not specified)
1 = 1 ton
1.5 = 1.5 ton
etc.

Table 5.12b

Heavy Trucks - Sorted by Model Year, 1983

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1983 (km/a)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
2	Truck, Reo, 1948	383	47.0	815	ht	48	g	36			
20	Truck, 1 ton, GMC, 1949	651	35.0	1860	ht	49	g	35			
5	Truck, 1.5 ton, IHC, 1952	159	50.4	315	1.5	52	g	32			
12	Truck, 1.5 ton, GMC, 1954	191	35.3	541	1.5	54	g	30			
16	Truck, 2.5 ton, GMC, 1956	850	42.7	1991	2.5	56	g	28			
16	Truck, 2.5 ton, GMC, 1956	180	42.7	422	2.5	56	g	28			
6	Truck, 3 ton, Chevrolet, 1960	1219	35.7	3415	3	60	g	24			
9	Truck, 1 ton, IHC, 1960	837	36.0	2325	1	60	g	24			
20	Truck, 2 ton, Chev, 1960	561	47.0	1194	2	60	g	24			
3	Truck, 4 ton, Ford, 1964	908	77.5	1172	4	64	g	20			
6	Truck, 3 ton, Ford, 1964	1289	37.8	3410	3	64	g	20			
12	Truck, 3 ton, GMC, 1964	570	34.6	1647	3	64	g	20			
2	Truck, 4 ton, Chev, 1965	311	70.0	444	4	65	g	19			
11	Truck, 2 ton, IHC, 1966	498	33.0	1509	2	66	g	18			
13	Truck, 1 ton, GMC, 1966	411	43.2	951	1	66	g	18			
22	Truck, 3 ton, IHC, 1968	1500	58.1	2582	3	68	g	16			
23	Truck, 2.5 ton, GMC, 1969	945	32.6	2899	2.5	69	g	15			
1	Truck, 3 ton, Ford, 1970	1355	63.0	2151	3	70	g	14		older 19	
13	Truck, 3 ton, IHC, 1970	2083	65.6	3175	3	70	g	14	14901	45.4	32817
17	Truck, Ford, 1970	150	43.2	347	ht	70	g	14	median		
15	Truck, tandem, Ford, 1971	6454	58.9	10958	ht	71	d	13	46228	46.6	99305
1	Truck, 3 ton, Ford, 1973	2111	63.0	3351	3	73	g	11		newer 19	
21	Truck, 3 ton, IHC 1600, 1973	3566	51.6	6911	3	73	g	11			
5	Truck, 3 ton, Dodge 600, 1974	2063	69.7	2960	3	74	g	10			
7	Truck, tandem, GMC, 1974	961	41.0	2344	ht	74	g	10			
18	Truck, 3 ton, GMC 6500, 1974	2069	25.9	7988	3	74	g	10			
2	Truck, 3 ton, Dodge, 1975	2596	65.9	3939	3	75	g	9			
16	Truck, 3 ton, GMC, 1975	2545	41.1	6192	3	75	g	9			
22	Truck, 3 ton, Dodge, 1975	1500	48.7	3080	3	75	g	9			
6	Truck, 3 ton, GMC, 1976	1552	52.1	2979	3	76	g	8			
14	Truck, 3 ton, Chev, 1976	2328	43.1	5401	3	76	g	8			
14	Truck, 2 ton, Chev, 1976	231	25.0	924	2	76	g	8			
10	Truck, IHC 4070a, 1977	4000	51.0	7843	ht	77	d	7			
19	Truck, 2 ton, Chev, 1977	626	44.6	1404	2	77	g	7			
7	Truck, 3 ton, GMC, 1978	2965	42.3	7009	3	78	g	6			
17	Truck, 3 ton, Ford 600, 1979	1438	40.2	3577	3	79	g	5			
21	Truck, 3 ton, Chev 60, 1980	123	54.4	226	3	80	g	4			
18	Truck, 3 ton, GMC 6500, 1981	5669	38.0	14918	3	81	g	3			
20	Truck, 3 ton, Chev, 1981	3431	47.0	7300	3	81	g	3			
	39	61279	46.3	132470				15.4			

VEHICLE TYPE:

ht = heavy truck (capacity not specified)
1 = 1 ton
1.5 = 1.5 ton
etc.

Figure 5.13a

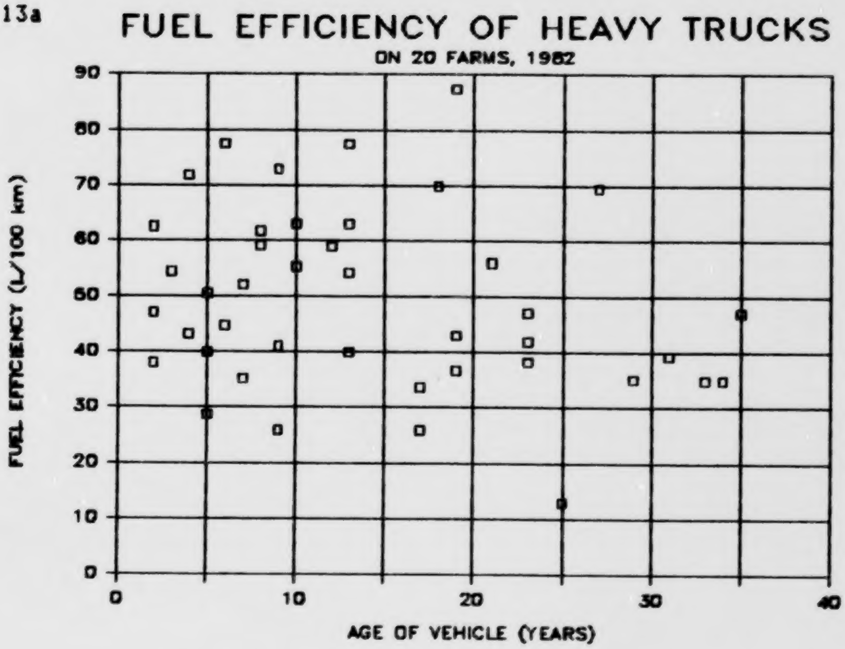


Figure 5.13b

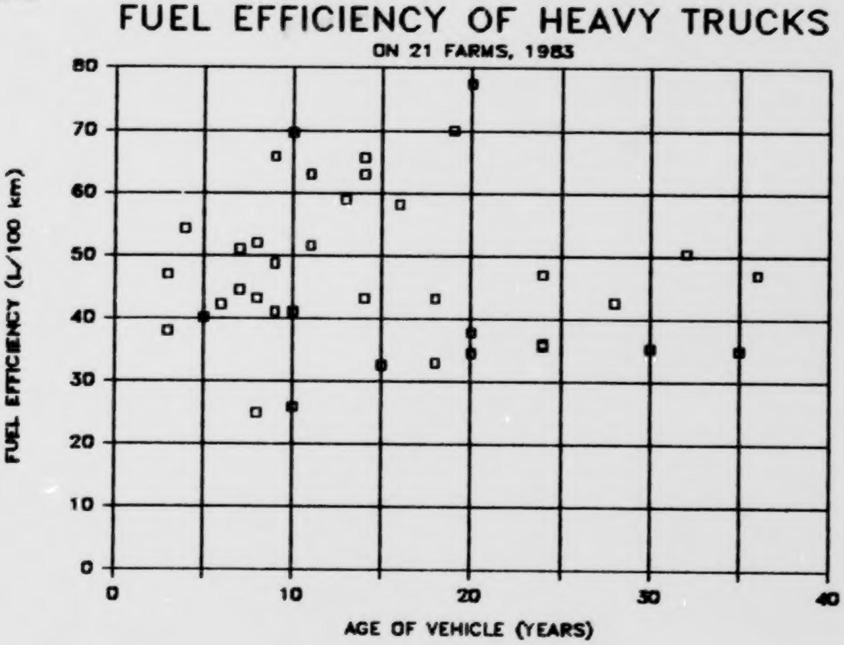


Table 5.13a

Heavy Trucks - Sorted by Fuel Efficiency, 1982

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1982 (km/a)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
3	Truck, 4 ton, Ford, 1964	1261	87.4	1443	4	64	g	19			
17	Truck, Ford, 1970	187	77.4	242	ht	70	g	13			
10	Truck, IHC 4070a, 1977	9084	77.4	11736	ht	77	d	6			
5	Truck, 3 ton, Dodge 600, 1974	2423	73.0	3319	3	74	g	9			
8	Truck, semi, Ford 9000, 1979	6287	71.9	8744	ht	79	d	4			
2	Truck, 4 ton, Chev, 1965	1688	70.0	2411	4	65	g	18			
16	Truck, 2.5 ton, GMC, 1956	343	69.4	494	2.5	56	g	27			
1	Truck, 3 ton, Ford, 1973	2130	63.0	3381	3	73	g	10			
1	Truck, 3 ton, Ford, 1970	1057	63.0	1678	3	70	g	13			
8	Truck, tandem, IHC, 1981	5992	62.5	9587	ht	81	d	2			
16	Truck, 3 ton, GMC, 1975	1703	61.8	2756	3	75	g	8			
2	Truck, 3 ton, Dodge, 1975	2763	59.2	4667	3	75	g	8			
15	Truck, tandem, Ford, 1971	6169	58.9	10474	ht	71	d	12			
8	Truck, 3 ton, Ford, 1962	811	56.0	1448	3	62	g	21			
21	Truck, 3 ton, IHC 1600, 1973	2667	55.3	4823	3	73	g	10			
21	Truck, 3 ton, Chev 60, 1980	863	54.4	1586	3	80	g	3			
8	Truck, 1 ton, IHC 1310, 1970	762	54.1	1409	1	70	g	13			
6	Truck, 3 ton, GMC, 1976	1658	52.1	3182	3	76	g	7			
7	Truck, 3 ton, GMC, 1978	1711	50.5	3388	3	78	g	5		less efficient	21
20	Truck, 2 ton, Chev, 1960	258	47.0	549	2	60	g	23	51876	63.5	81698
20	Truck, 3 ton, Chev, 1981	2059	47.0	4381	3	81	g	2	median		
2	Truck, Reo, 1948	491	47.0	1045	ht	48	g	35	median		
19	Truck, 2 ton, Chev, 1977	541	44.6	1213	2	77	g	6	29209	36.2	80611
17	Truck, 3 ton, Ford 600, 1979	1336	43.3	3085	3	79	g	4		more efficient	21
12	Truck, 3 ton, GMC, 1964	986	43.0	2293	3	64	g	19			
6	Truck, 3 ton, Chevrolet, 1960	674	41.8	1612	3	60	g	23			
7	Truck, tandem, GMC, 1974	837	41.0	2041	ht	74	g	9			
8	Truck, tandem, IHC, 1978	2890	40.0	7225	ht	78	g	5			
13	Truck, 3 ton, IHC, 1970	2712	40.0	6780	3	70	g	13			
5	Truck, 1.5 ton, IHC, 1952	111	39.4	282	1.5	52	g	31			
9	Truck, 1 ton, IHC, 1960	695	38.3	1815	1	60	g	23			
18	Truck, 3 ton, GMC 6500, 1981	7610	38.0	20026	3	81	g	2			
6	Truck, 3 ton, Ford, 1964	1998	36.7	5444	3	64	g	19			
14	Truck, 3 ton, Chev, 1976	2002	35.3	5671	3	76	g	7			
12	Truck, 1.5 ton, GMC, 1954	411	35.3	1164	1.5	54	g	29			
20	Truck, 1 ton, IHC, 1950	70	35.0	200	1	50	g	33			
20	Truck, 1 ton, GMC, 1949	353	35.0	1009	ht	49	g	34			
11	Truck, 2 ton, IHC, 1966	1313	33.8	3885	2	66	g	17			
8	Truck, 1 ton, Chevrolet, 1978	1698	28.7	5916	1	78	g	5			
13	Truck, 1 ton, GMC, 1966	321	26.0	1235	1	66	g	17			
18	Truck, 3 ton, GMC 6500, 1974	2074	25.9	8008	3	74	g	9			
6	Truck, 1 ton, Chev, 1958	86	13.0	662	1	58	g	25			
	- 42	81085	50.0	162309				14			

Table 5.13b

Heavy Trucks - Sorted by Fuel Efficiency, 1983

FARM NO	VEHICLE	FUEL USED (L)	FUEL EFFICIENCY (L/100 km)	DISTANCE DRIVEN 1983 (km/a)	VEHICLE TYPE	MODEL YEAR	FUEL TYPE	AGE			
3	Truck, 4 ton, Ford, 1964	908	77.5	1172	4	64	g	20			
2	Truck, 4 ton, Chev, 1965	311	70.0	444	4	65	g	19			
5	Truck, 3 ton, Dodge 600, 1974	2063	69.7	2960	3	74	g	10			
2	Truck, 3 ton, Dodge, 1975	2596	65.9	3939	3	75	g	9			
13	Truck, 3 ton, IHC, 1970	2083	65.6	3175	3	70	g	14			
1	Truck, 3 ton, Ford, 1973	2111	63.0	3351	3	73	g	11			
1	Truck, 3 ton, Ford, 1970	1355	63.0	2151	3	70	g	14			
15	Truck, tandem, Ford, 1971	6454	58.9	10958	ht	71	d	13			
22	Truck, 3 ton, IHC, 1968	1500	58.1	2582	3	68	g	16			
21	Truck, 3 ton, Chev 60, 1980	123	54.4	226	3	80	g	4			
6	Truck, 3 ton, GMC, 1976	1552	52.1	2979	3	76	g	8			
21	Truck, 3 ton, IHC 1600, 1973	3566	51.6	6911	3	73	g	11			
10	Truck, IHC 4070a, 1977	4000	51.0	7843	ht	77	d	7			
5	Truck, 1.5 ton, IHC, 1952	159	50.4	315	1.5	52	g	32			
22	Truck, 3 ton, Dodge, 1975	1500	48.7	3080	3	75	g	9			
2	Truck, Reo, 1948	383	47.0	815	ht	48	g	36			
20	Truck, 3 ton, Chev, 1981	3431	47.0	7300	3	81	g	3			less efficient 19
20	Truck, 2 ton, Chev, 1960	561	47.0	1194	2	60	g	24	35282	56.2	62798
19	Truck, 2 ton, Chev, 1977	626	44.6	1404	2	77	g	7	median		
13	Truck, 1 ton, GMC, 1966	411	43.2	951	1	66	g	18	median		
17	Truck, Ford, 1970	150	43.2	347	ht	70	g	14	25766	37.5	68748
14	Truck, 3 ton, Chev, 1976	2328	43.1	5401	3	76	g	8			more efficient 19
16	Truck, 2.5 ton, GMC, 1956	850	42.7	1991	2.5	56	g	28			
16	Truck, 2.5 ton, GMC, 1956	180	42.7	422	2.5	56	g	28			
7	Truck, 3 ton, GMC, 1978	2965	42.3	7009	3	78	g	6			
16	Truck, 3 ton, GMC, 1975	2545	41.1	6192	3	75	g	9			
7	Truck, tandem, GMC, 1974	961	41.0	2344	ht	74	g	10			
17	Truck, 3 ton, Ford 600, 1979	1438	40.2	3577	3	79	g	5			
18	Truck, 3 ton, GMC 6500, 1981	5669	38.0	14918	3	81	g	3			
6	Truck, 3 ton, Ford, 1964	1289	37.8	3410	3	64	g	20			
9	Truck, 1 ton, IHC, 1960	837	36.0	2325	1	60	g	24			
6	Truck, 3 ton, Chevrolet, 1960	1219	35.7	3415	3	60	g	24			
12	Truck, 1.5 ton, GMC, 1954	191	35.3	541	1.5	54	g	30			
20	Truck, 1 ton, GMC, 1949	651	35.0	1860	ht	49	g	35			
12	Truck, 3 ton, GMC, 1964	570	34.6	1647	3	64	g	20			
11	Truck, 2 ton, IHC, 1966	498	33.0	1509	2	66	g	18			
23	Truck, 2.5 ton, GMC, 1969	945	32.6	2899	2.5	69	g	15			
18	Truck, 3 ton, GMC 6500, 1974	2069	25.9	7988	3	74	g	10			
14	Truck, 2 ton, Chev, 1976	231	25.0	924	2	76	g	8			
	39	61279	46.3	132470				15.4			

Figure 5.14a

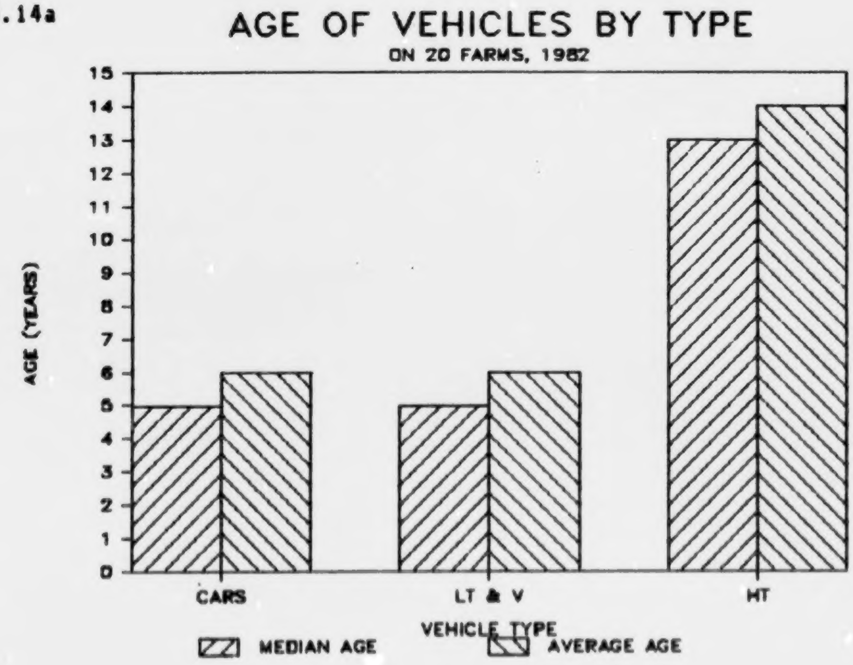
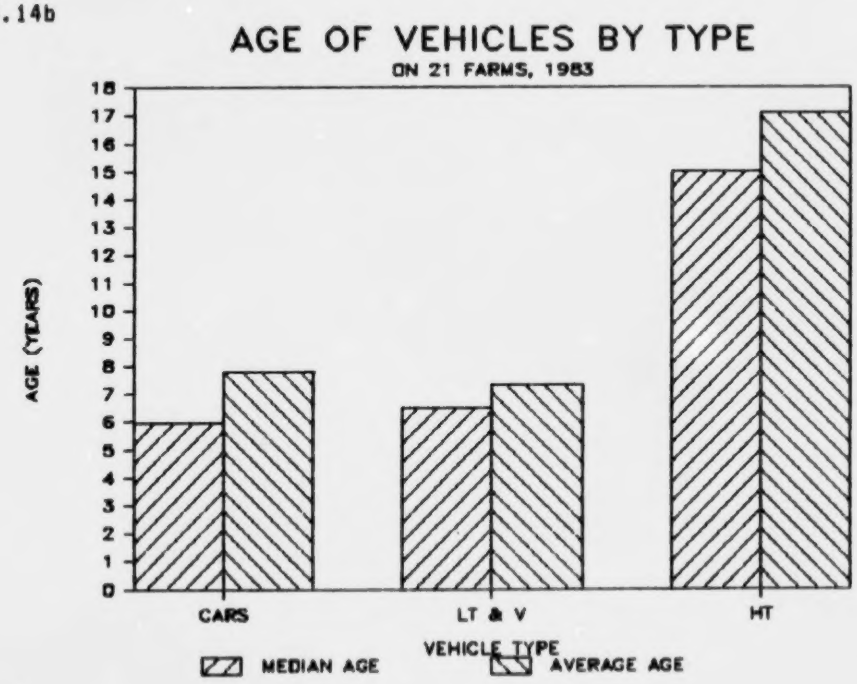


Figure 5.14b



LT&V=light trucks & vans
HT =heavy trucks

Figure 5.15a

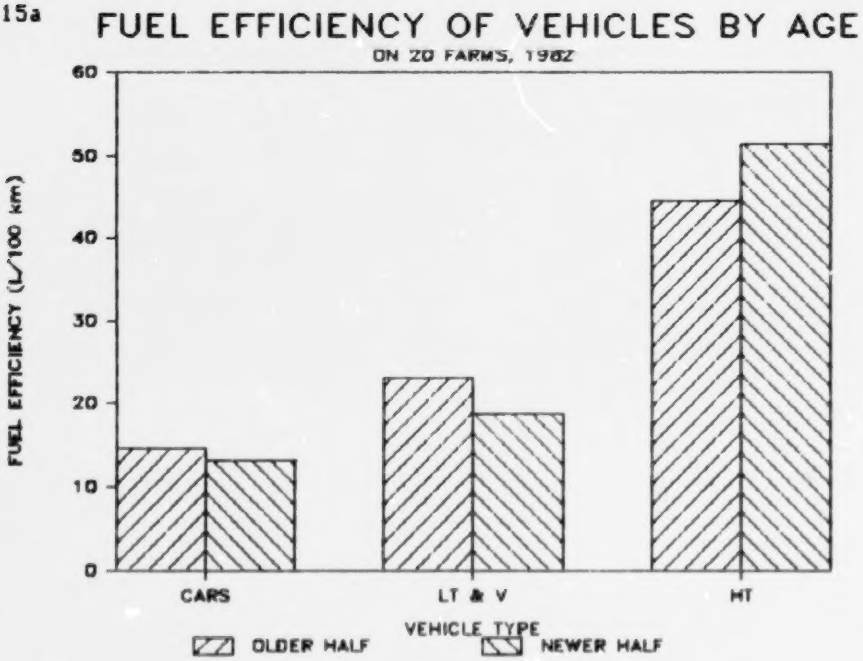
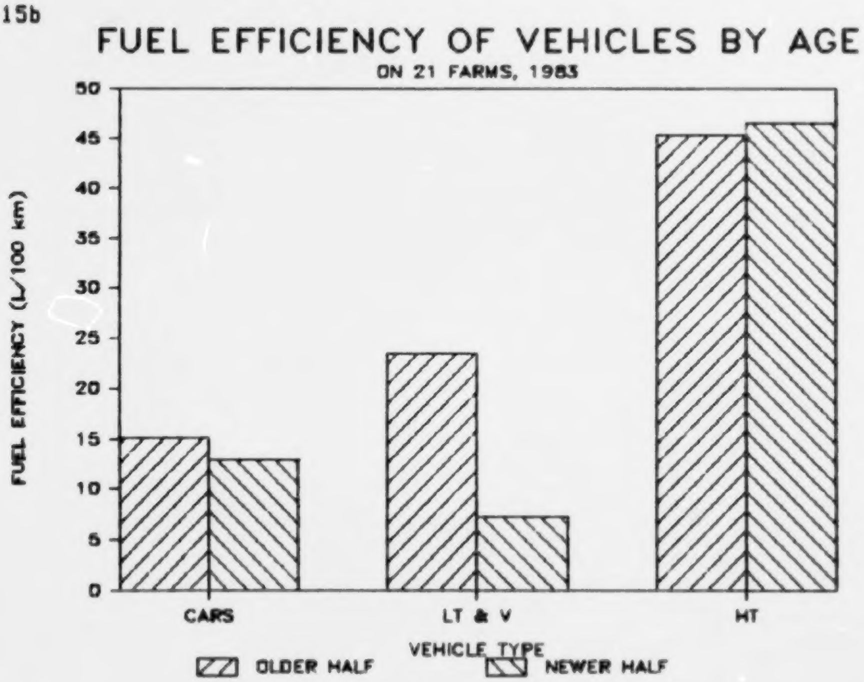


Figure 5.15b



LT&V=light trucks & vans
HT =heavy trucks

Figure 5.16a

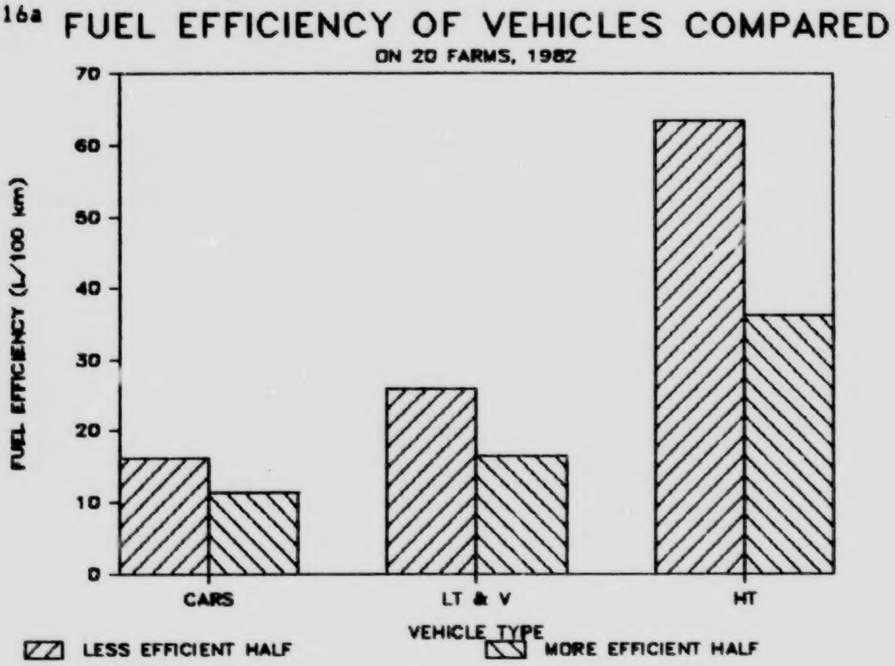
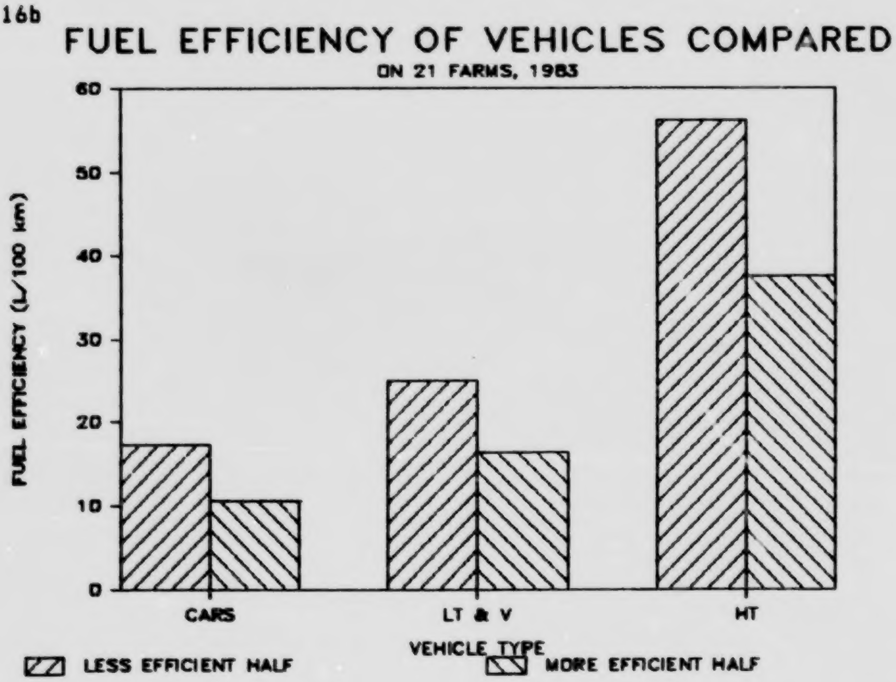


Figure 5.16b



LT&V=light trucks & vans
HT =heavy trucks

group (Figure 5.17a (5.17b)) by the average fuel efficiency of the group. The results are displayed in Figure 5.18a (5.18b). The total distance travelled in 1982 (1983) by all vehicles on the 20 (21) farms was approximately 1 380 000 (1 420 000) km. At an average (on-farm and highway) speed of 65 km/h (40.4 mph) this implies a total driving time of 21 200 (21 800) h for the 20 (21) farms, or an average of 1060 (1040) h per farm.

Fleet efficiency

Fleet efficiencies were calculated for the cars and light trucks on each farm in 1982 (1983). These are shown, ranked in order of decreasing fuel efficiency, in Table 5.14a (5.14b). In 1982, fleet efficiencies ranged from 10.0 L/100 km (28.2 mpg) to 23.4 L/100 km (12.1 mpg) and averaged 17.3 L/100 km (16.3 mpg) for 20 farms. In 1983, fleet efficiencies ranged from 10.0 L/100 km (28.2 mpg) to 23.9 L/100 km (11.8 mpg) and averaged 17.1 L/100 km (16.5 mpg) for 21 farms. The tables also show the fleet fuel efficiency for each farm as a percentage of the average fuel efficiency and as a percentage of the best fuel efficiency. The fleet efficiencies for 1983 are presented graphically in Figure 5.19.

Liquid Fuel Use by Operation

Table 5.15a (5.15b) shows the use of liquid fuel energy (diesel fuel and gasoline) on 20 (21) farms in 1982 (1983) by operation. Definitions of the operations categories are those used in the fuel log analysis (p. 5.6). The reader is urged to inspect these. For Table 5.15a (5.15b) some of the fuel log categories have been combined as explained in the footnotes to the table.

Several indices of liquid fuel energy use per unit of total cultivated area (column 8) were calculated.

Column 22 shows total liquid fuel energy use (column 21) in GJ/ha.

Column 23 shows total on-farm liquid fuel energy use (column 18) in GJ/ha.

Column 24 shows the total liquid fuel energy used in production operations (column 15) in GJ/ha.

Column 25 shows the total liquid fuel energy used in cropping operations (the sum of columns 11, 12 and 13) in GJ/ha.

Columns 26, 27, 28 and 29 show the indices of columns 22, 23, 24 and 25, respectively, in liters of diesel fuel equivalent (38.7 MJ/L) per hectare (L/ha). The results are displayed graphically as follows:

column 26 in Figure 5.20a (5.20b);
column 28 in Figure 5.21a (5.21b);
column 29 in Figure 5.22a (5.22b).

A comparison of total liquid fuel use per hectare (column 26) and the portion used in crop production (column 29) is shown in Figure 5.23a (5.23b).

Table 5.15a (5.15b) was sorted on column 27 (Table 5.16a (5.16b)). Total on-farm liquid fuel use ranged from 26 to 156 (26 to 133) L/ha.

Table 5.15a (5.15b) was sorted on column 28 (Table 5.17a (5.17b)).

Figure 5.17a

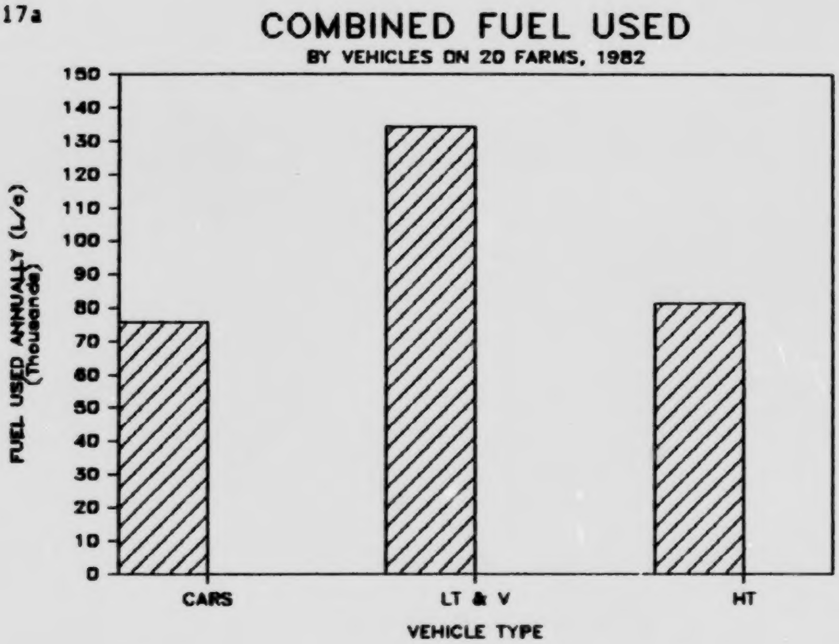
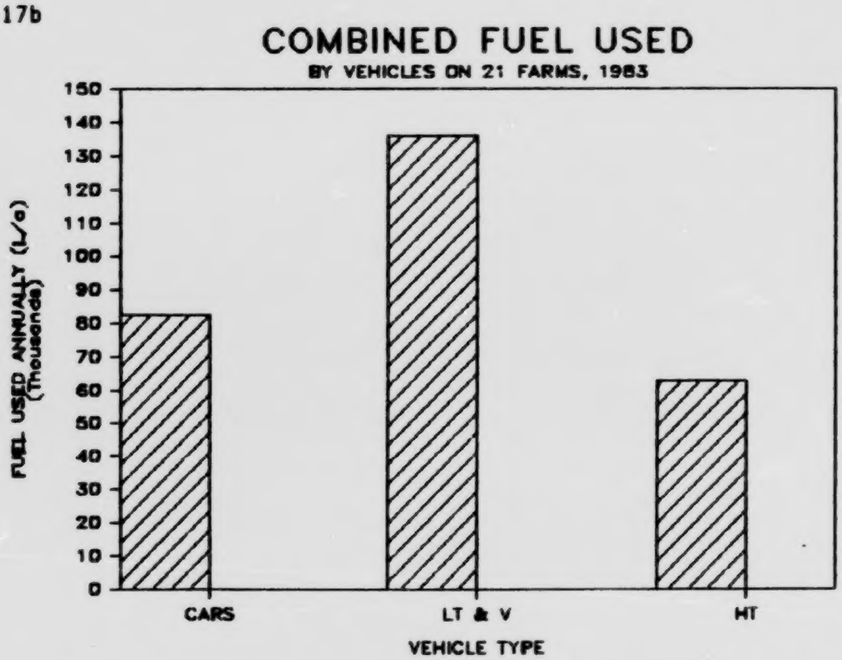


Figure 5.17b



LT&V=light trucks & vans
HT =heavy trucks

Figure 5.18a

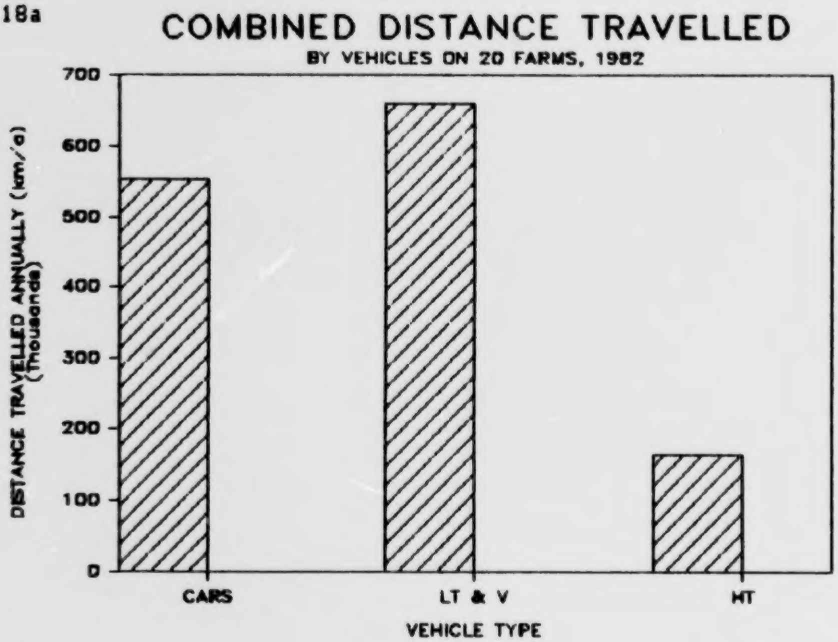
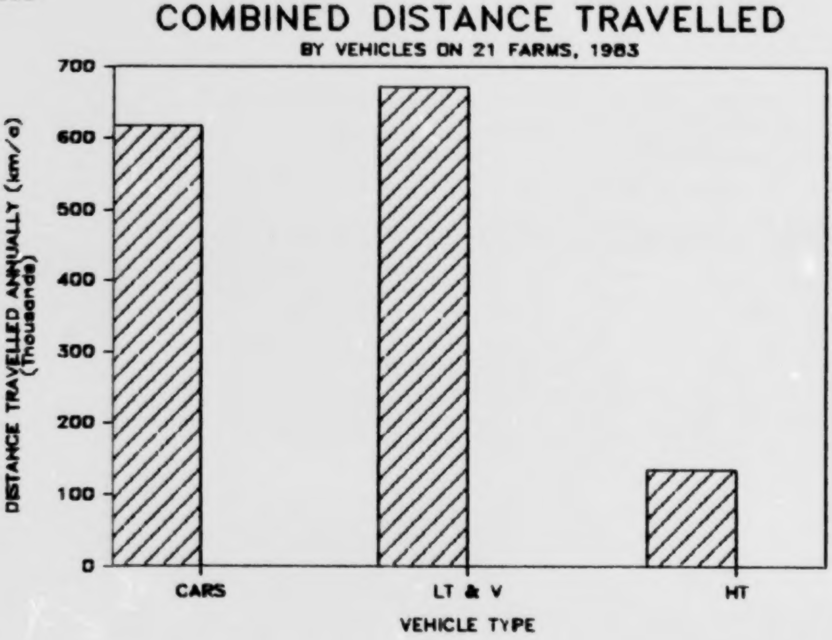


Figure 5.18b



LT&V=light trucks & vans
HT =heavy trucks

Table 5.14a

FLEET EFFICIENCY - CARS & TRUCKS - 1982

	fuel use	fuel efficiency			distance driven	fuel efficiency	
						% of average	% of best
Farm No.	L/a	L/100 km	km/L	mpg	km/a		
11	1952	10.0	10.0	28	19611	58	100
14	9624	11.6	8.6	24	82672	67	117
16	3834	14.3	7.0	20	26752	83	144
17	5354	15.1	6.6	19	35477	87	152
20	10149	15.4	6.5	18	65835	89	155
12	7781	15.5	6.5	18	50325	89	155
5	6050	16.1	6.2	18	37554	93	162
2	16947	16.2	6.2	17	104591	94	163
9	4275	16.5	6.1	17	25880	96	166
1	6670	16.6	6.0	17	40264	96	166
13	3698	16.7	6.0	17	22187	96	167
8	22809	17.8	5.6	16	128148	103	179
10	7879	18.1	5.5	16	43568	105	182
18	16130	18.1	5.5	16	89156	105	182
7	28295	18.5	5.4	15	153106	107	186
19	7023	18.7	5.3	15	37524	108	188
15	18234	19.1	5.2	15	95537	110	192
6	15086	19.9	5.0	14	75871	115	200
21	7559	22.3	4.5	13	33945	129	224
3	9644	23.4	4.3	12	41150	136	235
	208993	17.3	5.8	16.3	1209151	100	174

Table 5.14b

FLEET EFFICIENCY - CARS & LIGHT TRUCKS - 1983

	fuel use	fuel efficiency			distance driven	fuel efficiency	
						% of average	% of best
Farm No.	L/a	L/100 km	km/L	mpg	km/a		
11	2402	10.0	10.0	28	24116	58	100
14	10113	12.8	7.8	22	79156	75	128
23	3675	13.9	7.2	20	26406	82	140
16	4422	13.9	7.2	20	31740	82	140
17	4328	14.1	7.1	20	30756	82	141
19	6750	15.1	6.6	19	44768	88	151
5	7274	15.1	6.6	19	48143	89	152
1	6683	15.9	6.3	18	42002	93	160
9	4668	16.1	6.2	18	28981	94	162
13	18716	16.5	6.1	17	113507	97	166
18	19361	16.6	6.0	17	116314	98	167
15	19693	16.7	6.0	17	117987	98	168
6	14133	17.6	5.7	16	80132	103	177
22	7182	17.7	5.6	16	40467	104	178
2	17645	18.5	5.4	15	95601	108	185
7	26798	18.5	5.4	15	144942	108	186
20	6394	18.9	5.3	15	33918	110	189
12	6736	19.5	5.1	14	34550	114	196
10	9439	20.2	5.0	14	46750	118	203
21	8209	21.4	4.7	13	38342	125	215
3	11828	23.9	4.2	12	49555	140	240
	216449	17.1	5.9	16.5	1268133	100	171

Figure 5.19 FLEET EFFICIENCY OF CARS & PICKUPS

ON 21 FARMS, 1983

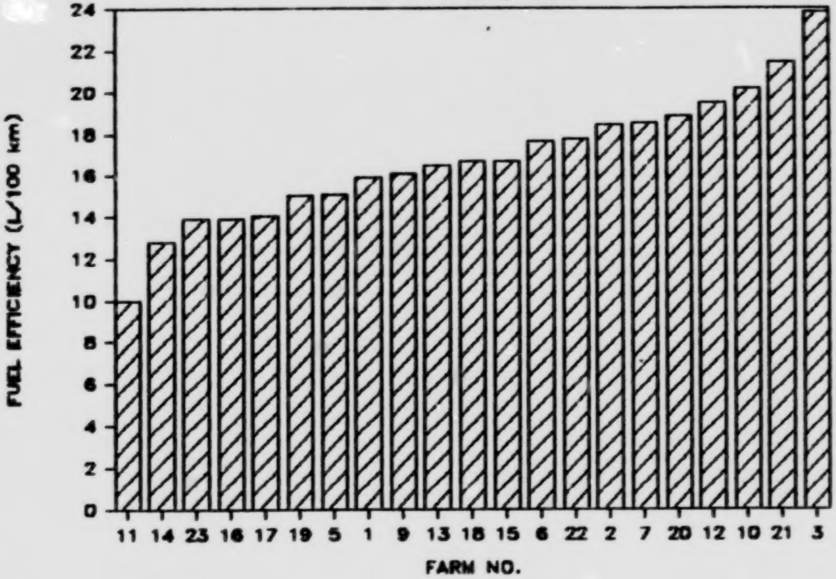


TABLE 5.15a LIQUID FUEL ENERGY USE ON 20 SASKATCHEWAN FARMS, 1980, PER UNIT AREA

FARM NO.	LOCATION	SOIL ZONE	CULTIVATED AREA (ha): ANNUAL CROPS	PERENNIAL CROPS	TOTAL CROPS	SUMMER-FALLOW	TOTAL CULT.	CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE (GJ): PRODUCTION OPERATIONS: CROP PRODUC-TION	SMF & WEED CONTROL	HARVEST & HAULING	OTHER	TOTAL	OTHER FARM USE	TRANS-PORT-ATION	TOTAL FARM USE	WORK SUPPLIED: DONE FOR OTHERS	TO OTHERS	TOTAL	ENERGY USE PER UNIT AREA (GJ/ha)				FUEL USE PER UNIT AREA (L/ha) (diesel fuel equivalent)			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
*		*																								*	*	*
11	Cochin	Bl	121	40	161	116	277	Grain & Hay	--	34	92	55	7	188	10	86	284	0	0	284	1.0	1.0	0.7	0.7	26	26	18	17
7	Humboldt	Bl	352	6	358	340	698	Grain	Hogs	206	236	306	7	755	55	981	1791	0	19	1810	2.6	2.6	1.1	1.1	67	66	28	28
21	Dilworth	Bl	391	0	391	212	603	Grain & Silage	Dairy	219	265	226	386	1096	16	289	1401	0	42	1443	2.4	2.3	1.8	1.2	62	60	47	30
3	Calder	Bl	384	124	508	15	523	Grain & Hay	Beef	115	235	269	361	980	66	521	1567	0	11	1578	3.0	3.0	1.9	1.2	78	77	48	31
6	Tisdale	Bl	488	103	591	73	664	Grain & Hay	Beef	251	227	334	192	1004	16	518	1540	4	8	1552	2.3	2.3	1.5	1.2	60	60	39	32
12	Humboldt	Bl	114	16	130	60	190	Grain & Hay	Beef	85	57	96	81	319	41	256	616	0	0	616	3.2	3.2	1.7	1.3	84	84	43	32
8	Marsden	Bl	1900	0	1900	243	2143	Grain	--	1307	456	1457	0	3220	80	860	4160	0	43	4203	2.0	1.9	1.5	1.5	51	50	39	39
1	Weldon	Bl	477	0	477	71	548	Grain	Beef	407	152	266	92	917	9	246	1172	0	11	1183	2.2	2.1	1.7	1.5	56	55	43	39
19	Maple Creek	Br	109	0	109	12	121	Hay & Silage	Beef	15	9	15	154	193	1	189	383	0	0	383	3.2	3.2	1.6	0.3	82	82	41	8
18	Fergman	Br	55	121	176	0	176	Hay	Dairy	0	58	5	741	804	3	257	1064	0	2	1066	6.1	6.0	4.6	0.4	157	156	118	9
20	Eston	Br	486	0	486	473	959	Grain	--	120	290	244	0	654	21	350	1025	0	3	1028	1.1	1.1	0.7	0.7	28	28	18	18
14	Mossbank	Br	404	0	404	409	813	Grain	--	170	313	218	4	705	14	330	1049	0	4	1052	1.3	1.3	0.9	0.9	33	33	22	22
16	McGee	Br	668	0	668	627	1295	Grain	--	746	0	526	0	1272	0	556	1828	0	0	1828	1.4	1.4	1.0	1.0	36	36	25	25
5	Regina	Br	337	0	337	177	514	Grain	--	158	159	209	13	539	21	211	771	0	8	779	1.5	1.5	1.0	1.0	39	39	27	26
10	Kerrobert	Br	300	0	300	308	608	Grain	--	106	370	181	16	673	18	133	824	0	2	826	1.4	1.4	1.1	1.1	35	35	29	28
9	Landis	DBr	126	52	178	134	312	Grain & Hay	Sheep	53	21	54	34	162	5	153	320	0	7	327	1.0	1.0	0.5	0.4	27	27	13	11
17	Gull Lake	DBr	209	0	209	150	359	Grain & Silage	Beef	72	102	109	25	308	5	176	489	0	15	504	1.4	1.4	0.9	0.8	36	35	22	20
13	Spears	DBr	358	17	375	157	532	Grain & Hay	Hogs	94	121	241	103	559	5	126	690	0	0	690	1.3	1.3	1.1	0.9	34	34	27	22
15	Howard	DBr	1076	0	1076	658	1734	Grain	--	551	627	492	138	1808	61	744	2613	0	0	2613	1.5	1.5	1.0	1.0	39	39	27	25
2	Imperial	DBr	344	0	344	152	496	Grain	--	239	108	195	70	612	5	300	917	122	28	1068	2.2	1.8	1.2	1.1	56	48	32	28
									total	4948	3898	5499	2418	16763	454	7288	24504											
										20	16	22	10	68	2	30	100											

Farm no.	11	12	13	14	15	16	17	18
	%							
1	12	32	19	2	66	4	30	100
2	12	13	17	0	42	3	55	100
3	16	19	16	27	78	1	21	100
5	7	15	17	23	63	4	33	100
6	16	15	22	12	65	1	34	100
7	14	9	16	13	52	7	42	100
8	31	11	35	0	77	2	21	100
9	35	13	23	8	78	1	21	100
10	4	2	4	40	50	0	49	100
11	0	5	0	70	76	0	24	100
12	12	28	24	0	64	2	34	100
13	16	30	21	0	67	1	31	100
14	41	0	29	0	70	0	30	100
15	20	21	27	2	70	3	27	100
16	13	45	22	2	82	2	16	100
17	17	7	17	11	51	2	48	100
18	15	21	22	5	63	1	36	100
19	14	18	35	15	81	1	18	100
20	21	24	19	5	69	2	28	100
21	26	12	21	6	67	1	33	100

column 22 = total liquid fuel energy use per unit area
= column 21/column 8

column 23 = total on-farm liquid fuel energy use per unit area
= column 18/column 8

column 24 = total liquid fuel energy use in operations per unit area
= column 15/column 8

column 25 = total liquid fuel energy use in cropping per unit area
= (columns 11+12+13)/column 8

columns 26, 27, 28 and 29 (L/ha) correspond to columns 22, 23, 24, and 25 (GJ/ha); (1 GJ = 25.84 L diesel fuel)

NOTES:

Definitions of the operations categories are those used in the fuel log analysis (p. [illegible]). Some of these categories have been combined, as follows:

"Other production"	- includes "land improvement", "crop miscellaneous", "feed", "manure", "livestock miscellaneous" and "power generation";
"Other farm use"	- includes "farmstead" and "recreation";
"Work done for others	- includes all custom work done for others;
"Harvest & hauling"	- includes product hauling, both on- and off-farm;
"Transportation"	- includes all uses of cars and light trucks, except when it was indicated on the log sheets that the truck was used to haul a large load in which case the use was assigned to one of the other categories. - also includes one airplane (on farm 15)
* "Crop production"	- replaces "seeding"
Note:	- For farm 16, all field operations, except harvest operations are combined under "crop production"

Table 5.15b

TABLE 5.15b LIQUID FUEL ENERGY USE ON 21 SASKATCHEWAN FARMS, 1983, PER UNIT AREA

FARM NO.	LOCATION	SOIL ZONE	CULTIVATED AREA (ha): ANNUAL CROPS*	PERENNIAL CROPS	TOTAL CROPS	SUMMER-FALLOW	TOTAL CULT.	CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE (GJ): PRODUCTION OPERATIONS: CROP PRODUC-TION	SMF & WEED CONTROL	HARVEST & HAULING	OTHER	TOTAL	OTHER FARM USE	TRANS-PORT-ATION	TOTAL FARM USE	WORK DONE FOR OTHERS	SUPPLIED TO OTHERS	TOTAL	ENERGY USE PER UNIT AREA (GJ/ha)				FUEL USE PER UNIT AREA (L/ha) (diesel fuel equivalent)			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
*		$																								[illegible]	[illegible]	[illegible]
11	Cochin	Bl	117	44	161	105	266	Grain & Hay	--	49	59	57	13	178	6	110	296	0	0	296	1.1	1.1	0.7	0.6	29	29	17	16
23	Carragana	Bl	61	0	61	49	110	Grain		66	7	52	0	125	4	94	223	0	4	227	2.1	2.0	1.1	1.1	53	52	29	29
12	Humboldt	Bl	79	18	97	83	180	Grain & Hay	Beef	65	112	52	28	257	34	222	513	0	1	514	2.9	2.9	1.4	1.3	74	74	37	33
7	Humboldt	Bl	372	6	378	308	686	Grain	Hogs	221	336	335	57	949	97	929	1975	0	61	2036	3.0	2.9	1.4	1.3	77	74	36	34
2	Calder	Bl	343	87	430	283	713	Grain & Hay	Beef	227	440	283	374	1324	22	595	1941	0	13	1954	2.7	2.7	1.9	1.3	71	70	48	34
6	Tisdale	Bl	548	39	587	109	696	Grain & Hay	Beef	281	295	380	247	1203	22	481	1706	0	4	1710	2.5	2.5	1.7	1.4	63	63	45	35
21	Cudworth	Bl	349	76	425	178	603	Grain & Silage	Dairy	682	6	169	51	908	9	287	1204	0	105	1309	2.2	2.0	1.5	1.4	56	52	39	37
1	Weldon	Bl	488	0	488	83	571	Grain	Beef	282	224	349	145	1000	16	242	1258	0	19	1277	2.2	2.2	1.8	1.5	56	57	45	39
19	Maple Creek	Br	109	0	109	12	121	Hay & Silage	Beef	27	8	22	122	179	3	187	369	0	5	374	3.1	3.0	1.5	0.5	80	79	38	12
10	Fargman	Br	55	121	176	0	176	Hay	Dairy	77	2	13	556	648	10	246	904	0	246	1150	6.5	5.1	3.7	0.5	169	133	95	14
20	Eston	Br	486	0	486	482	968	Grain	--	197	234	311	3	745	4	216	965	0	1	966	1.0	1.0	0.8	0.8	26	26	20	20
22	Kindersley	Br	518	0	518	0	518	Grain		158	28	230	0	416	9	257	682	0	23	705	1.4	1.3	0.8	0.8	35	34	21	21
14	Rossbank	Br	516	0	516	304	820	Grain	--	209	269	230	4	712	5	349	1066	0	0	1066	1.3	1.3	0.9	0.9	34	34	22	22
16	Kerrobert	Br	322	0	322	306	628	Grain	--	196	206	232	0	634	27	138	799	0	8	807	1.3	1.3	1.0	1.0	33	33	26	26
5	Regina	Br	382	0	382	119	501	Grain	--	160	181	191	2	534	43	324	901	0	1	902	1.8	1.8	1.1	1.1	47	46	28	27
18	McGee	Br	674	0	674	572	1246	Grain	--	283	538	532	0	1353	11	668	2033	0	0	2033	1.6	1.6	1.1	1.1	42	42	28	28
9	Landis	DBr	158	0	158	154	312	Grain	Sheep	51	46	70	30	197	8	148	353	0	5	358	1.1	1.1	0.6	0.5	30	29	16	14
17	Bull Lake	DBr	215	0	215	130	345	Grain & Silage	Beef	111	91	111	22	335	7	134	476	0	0	476	1.4	1.4	1.0	0.9	36	36	25	23
15	Heward	DBr	1265	0	1265	465	1730	Grain	--	885	303	484	121	1793	53	828	2674	0	1	2675	1.5	1.5	1.0	1.0	40	40	27	25
13	Semans	DBr	361	17	378	157	535	Grain & Hay	Hogs	180	156	258	198	792	42	612	1446	0	2	1448	2.7	2.7	1.5	1.1	70	70	38	29
3	Imperial	DBr	504	0	504	0	504	Grain	--	346	220	211	37	814	21	393	1228	0	3	1231	2.4	2.4	1.6	1.5	63	63	42	40
									total	4753	3761	4572	2010	15096	455	7466	23012	0	502	23514								
										21	16	20	9	66	2	32	100											

* not incl silage

NOTES:

Definitions of the operations categories are those used in the fuel log analysis (p. 5.61). Some of these categories have been combined, as follows:

"Other production"	- includes "land improvement", "crop miscellaneous", "feed", "manure", "livestock miscellaneous" and "power generation";
"Other farm use"	- includes "farmstead" and "recreation";
"Work done for others	- includes all custom work done for others;
"Harvest & hauling"	- includes product hauling, both on- and off-farm;
"Transportation"	- includes all uses of cars and light trucks, except when it was indicated on the log sheets that the truck was used to haul a large load in which case the use was assigned to one of the other categories. - also includes one airplane (on farm 15)
* "Crop production"	- replaces "seeding"

farm no.	11	12	13	14	15	16	17	18
1	17	20	19	4	60	3	37	100
2	30	3	23	0	56	2	42	100
3	13	22	10	5	50	7	43	100
5	11	17	17	3	48	5	47	100
6	12	23	15	19	68	1	31	100
7	16	17	22	14	71	1	28	100
9	57	0	14	4	75	1	24	100
10	22	18	28	12	79	1	19	100
11	7	2	6	33	49	1	51	100
12	9	0	1	62	72	1	27	100
13	20	24	32	0	77	0	22	100
14	23	4	34	0	61	1	38	100
15	20	25	22	0	67	0	33	100
16	25	26	29	0	79	3	17	100
17	18	20	21	0	59	5	36	100
18	14	26	26	0	67	1	33	100
19	14	13	20	8	56	2	42	100
20	23	19	23	5	70	1	28	100
21	33	11	18	5	67	2	31	100
22	12	11	16	14	55	3	42	100
23	28	18	17	3	66	2	32	100

column 22 = total liquid fuel energy use per unit area
= column 21/column 8

column 23 = total on-farm liquid fuel energy use per unit area
= column 18/column 8

column 24 = total liquid fuel energy use in operations per unit area
= column 15/column 8

column 25 = total liquid fuel energy use in cropping per unit area
= (columns 11+12+13)/column 8

columns 26, 27, 28 and 29 (L/ha) correspond to columns 22, 23, 24, and 25 (GJ/ha); (1 GJ = 25.84 L diesel fuel)

Figure 5.20a

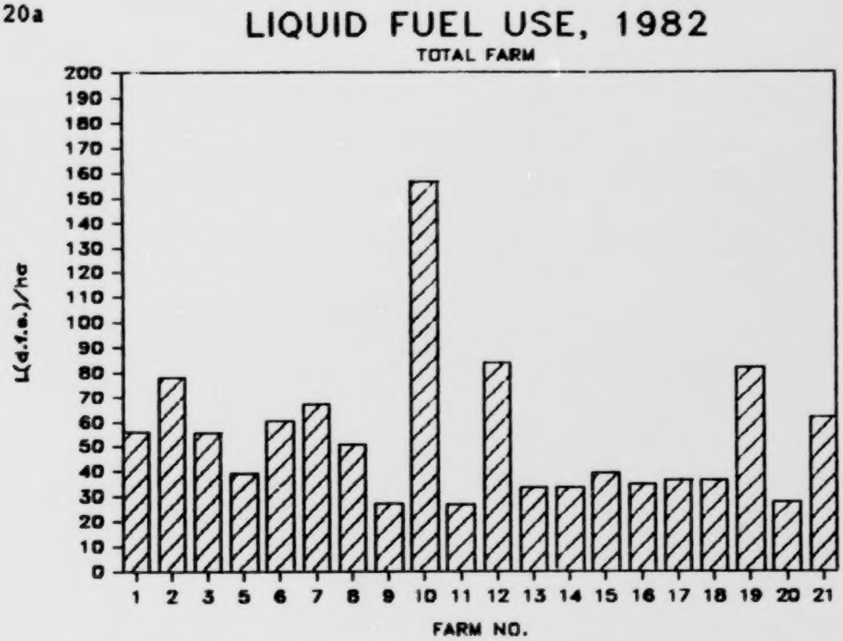
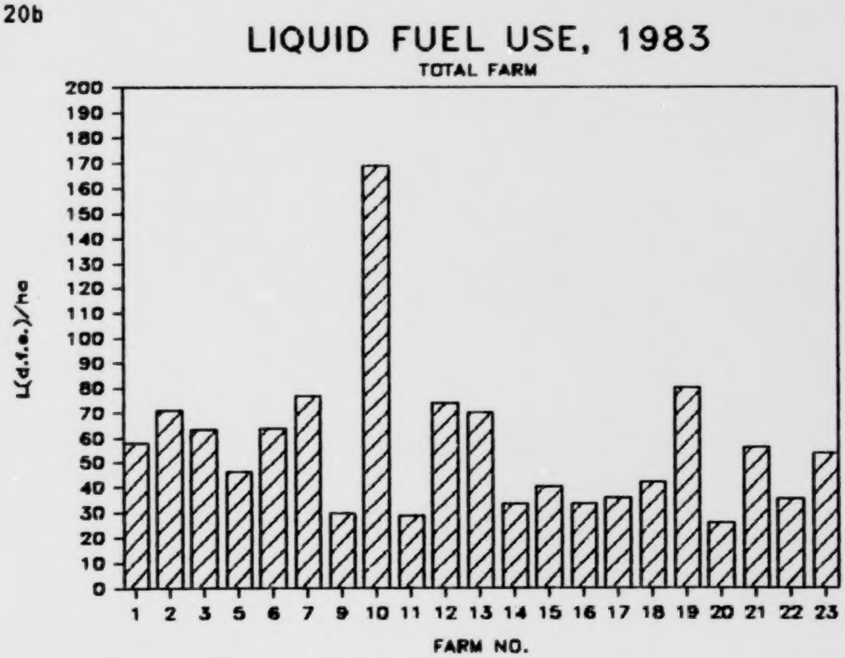


Figure 5.20b



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* farm no. 10 is a dairy with a small land base

Figure 5.21a

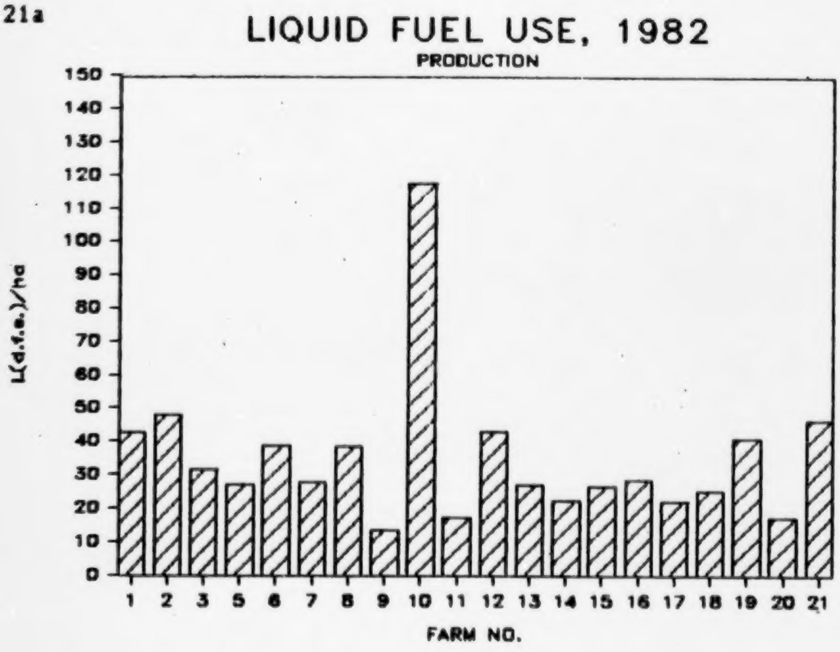
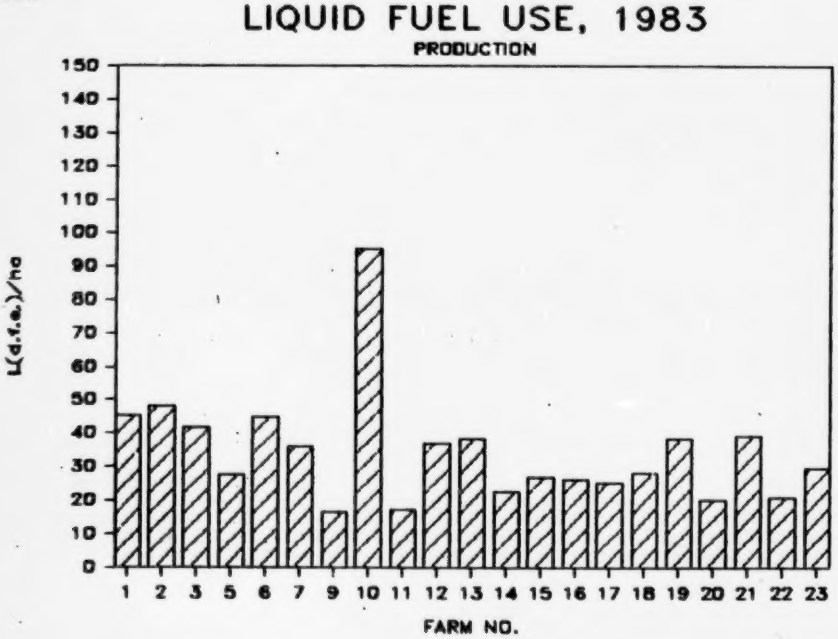


Figure 5.21b



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* farm no. 10 is a dairy with a small land base

Figure 5.22a

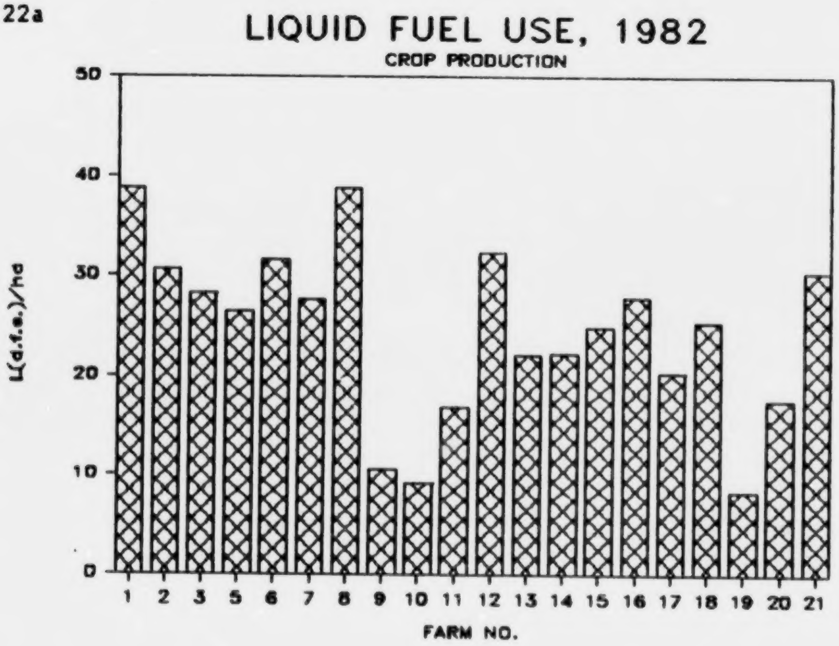


Figure 5.22b

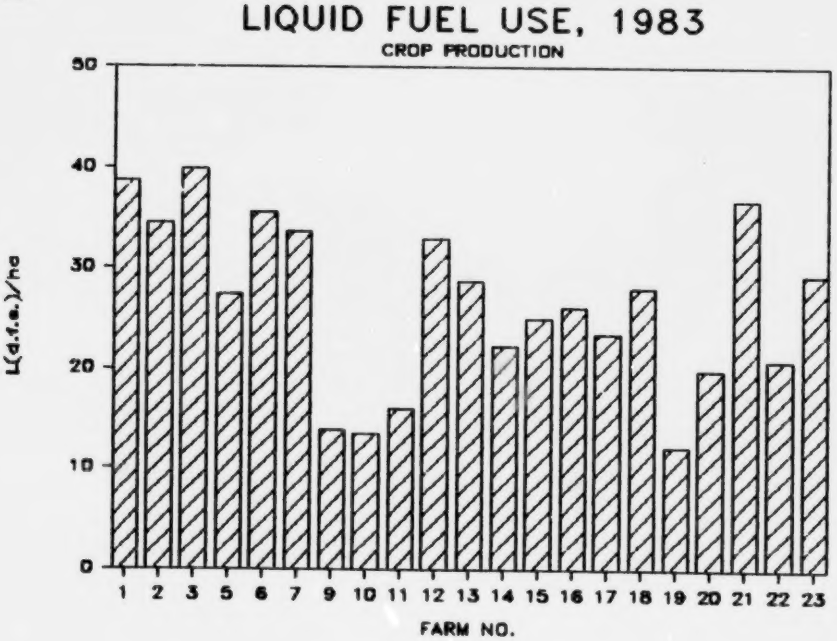


Figure 5.23a

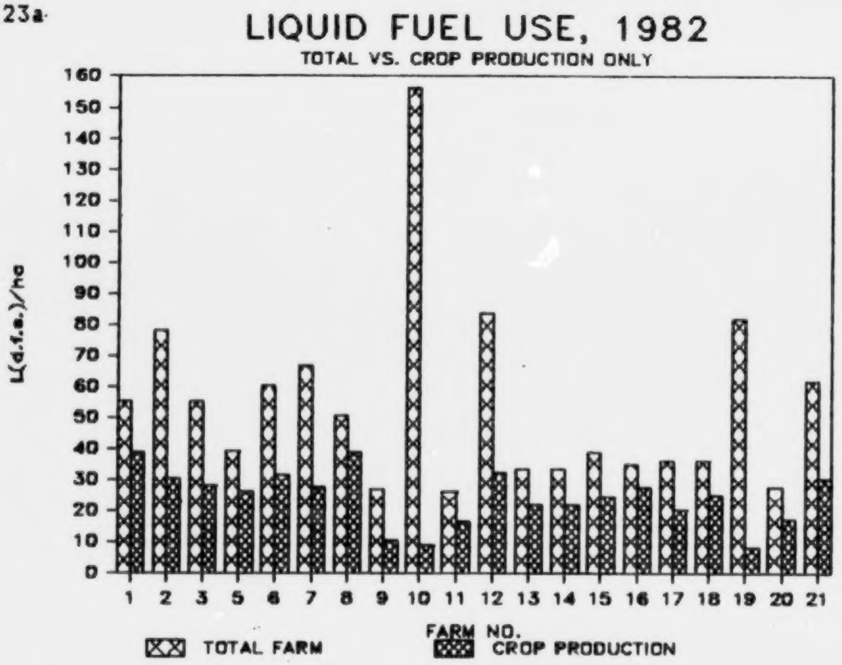
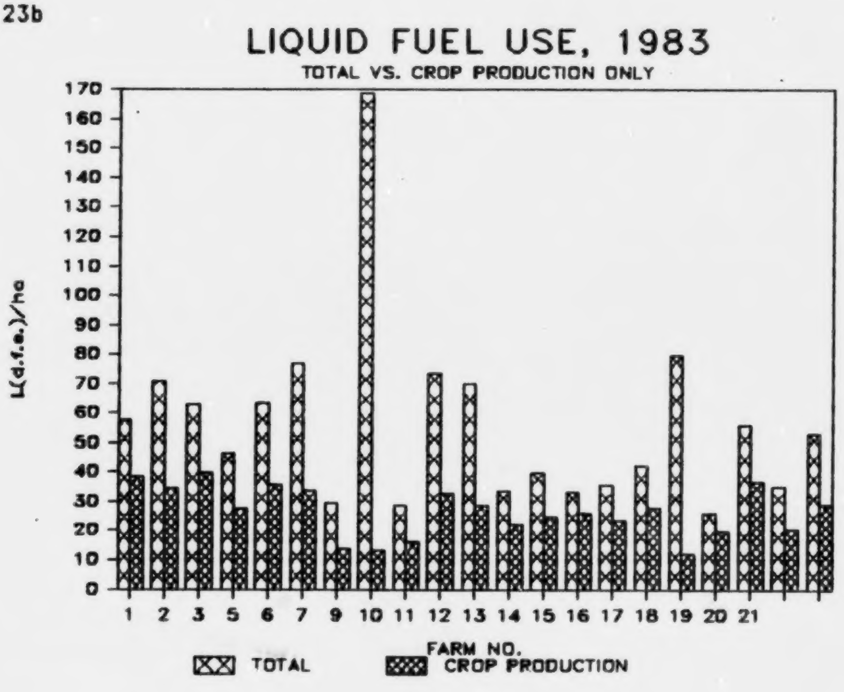


Figure 5.23b



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* farm no. 10 is a dairy with a small land base

Table 5.16a

TABLE 5.16a LIQUID FUEL ENERGY USE ON 20 SASKATCHEWAN FARMS, 1982, PER UNIT AREA

FARM NO.	LOCATION	SOIL ZONE	CULTIVATED AREA (ha)					CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE (GJ)											ENERGY USE PER UNIT AREA (GJ/ha)				FUEL USE PER UNIT AREA (L/ha) (diesel fuel equivalent)			
			ANNUAL CROPS	PERENNIAL CROPS	TOTAL CROPS	SUMMER-FALLOW	TOTAL CULT.			PRODUCTION OPERATIONS				TOTAL	OTHER FARM USE	TRANS-PORTATION	TOTAL FARM USE	WORK SUPPLIED		TOTAL								
										CROP PRODUCTION	SMF & WEED CONTROL	HARVEST & HAULING	OTHER					DONE FOR OTHERS	TO OTHERS									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
n		s																								x	y	z
11	Cochin	Bl	121	40	161	116	277	Grain & Hay	--	34	92	55	7	188	10	86	284	0	0	284	1.0	1.0	0.7	0.7	26	26	18	17
9	Lardis	DBr	126	52	178	134	312	Grain & Hay	Sheep	52	21	54	34	162	5	153	320	0	7	327	1.0	1.0	0.5	0.4	27	27	13	11
20	Eston	Br	486	0	486	473	959	Grain	--	120	290	244	0	654	21	350	1025	0	3	1028	1.1	1.1	0.7	0.7	28	28	18	16
14	Mossbank	Br	404	0	404	408	812	Grain	--	170	313	218	4	705	14	330	1049	0	4	1053	1.3	1.3	0.9	0.9	33	33	22	22
13	Semans	DBr	358	17	375	157	532	Grain & Hay	Hogs	94	121	241	103	559	5	126	690	0	6	696	1.3	1.3	1.1	0.9	34	34	27	22
16	Kerrobert	Br	300	0	300	308	608	Grain	--	106	370	181	16	673	16	135	824	0	2	826	1.4	1.4	1.1	1.1	35	35	29	28
17	Bull Lake	DBr	209	0	209	150	359	Grain & Silage	Beef	72	102	109	25	308	5	176	489	0	15	504	1.4	1.4	0.9	0.8	36	35	22	20
18	McGee	Br	668	0	668	627	1295	Grain	--	746	0	526	0	1272	0	556	1828	0	0	1828	1.4	1.4	1.0	1.0	36	36	25	25
5	Regina	Br	337	0	337	177	514	Grain	--	158	159	209	13	539	21	211	771	0	8	779	1.5	1.5	1.0	1.0	39	39	27	26
15	Howard	DBr	1076	0	1076	658	1734	Grain	--	551	627	492	138	1808	61	744	2613	0	6	2619	1.5	1.5	1.0	1.0	39	39	27	25
3	Imperial	DBr	344	0	344	152	496	Grain	--	239	108	195	70	612	5	300	917	123	26	1066	2.2	1.8	1.2	1.1	56	48	32	28
8	Marsden	Bl	1900	0	1900	243	2143	Grain	--	1307	456	1457	0	3220	80	860	4160	0	43	4203	2.0	1.9	1.5	1.5	51	50	39	39
1	Weldon	Bl	477	0	477	71	548	Grain	Beef	407	152	266	92	917	9	246	1172	0	11	1183	2.2	2.1	1.7	1.5	56	55	43	39
6	Tisdale	Bl	488	103	591	73	664	Grain & Hay	Beef	251	227	334	192	1004	18	518	1540	4	8	1552	2.3	2.3	1.5	1.2	60	60	39	32
21	Cudworth	Bl	391	0	391	212	603	Grain & Silage	Dairy	219	265	226	380	1090	16	295	1401	0	42	1443	2.4	2.3	1.8	1.2	62	60	47	30
7	Humboldt	Bl	352	6	358	340	698	Grain	Hogs	206	236	306	7	755	55	981	1791	0	19	1810	2.6	2.6	1.1	1.1	67	66	28	28
2	Calder	Bl	384	124	508	15	523	Grain & Hay	Beef	115	235	269	361	980	66	521	1567	0	11	1578	3.0	3.0	1.9	1.2	78	77	48	31
19	Maple Creek	Br	109	0	109	12	121	Hay & Silage	Beef	15	9	15	154	193	1	189	383	0	0	383	3.2	3.2	1.6	0.3	82	82	41	8
12	Humboldt	Bl	114	16	130	60	190	Grain & Hay	Beef	85	57	96	81	319	41	256	616	0	0	616	3.2	3.2	1.7	1.3	84	84	43	32
10	Fergmar	Br	55	121	176	0	176	Hay	Dairy	0	58	5	741	804	3	257	1064	0	2	1066	6.1	6.0	4.6	0.4	157	156	116	9

Table 5.16b

TABLE 5.16b LIQUID FUEL ENERGY USE ON 21 SASKATCHEWAN FARMS, 1983, PER UNIT AREA

FARM NO.	LOCATION	SOIL ZONE	CULTIVATED AREA (ha) ANNUAL CROPS*	PERENNIAL CROPS	TOTAL CROPS	SUMMER-FALLOW	TOTAL CULT.	CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE (GJ) PRODUCTION OPERATIONS CROP PRODUCTION	SNF & WEED CONTROL	HARVEST & HAULING	OTHER	TOTAL	OTHER FARM USE	TRANS-PORTATION	TOTAL FARM USE	WORK DONE FOR OTHERS	SUPPLIED TO OTHERS	TOTAL	ENERGY USE PER UNIT AREA (GJ/ha)				FUEL USE PER UNIT AREA (L/ha) (Diesel Fuel equivalent)			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
n		s																								x	y	z
20	Eston	Br	486	0	486	482	968	Grain	--	197	234	311	3	745	4	216	965	0	1	966	1.0	1.0	0.8	0.8	26	26	20	20
11	Cochin	Bl	117	44	161	105	266	Grain & Hay	--	49	59	57	13	178	8	110	296	0	0	296	1.1	1.1	0.7	0.6	29	29	17	16
9	Landis	DBr	156	0	156	154	310	Grain	Sheep	51	46	70	30	197	8	148	353	0	5	358	1.1	1.1	0.6	0.5	30	29	16	14
16	Kerrobert	Br	322	0	322	306	628	Grain	--	196	206	232	0	634	27	138	799	0	8	807	1.3	1.3	1.0	1.0	32	32	26	26
14	Mossbank	Br	516	0	516	304	820	Grain	--	208	265	236	4	712	5	349	1066	0	0	1066	1.3	1.3	0.9	0.9	34	34	22	22
22	Kindersley	Br	518	0	518	0	518	Grain		156	28	230	0	416	9	257	682	0	23	705	1.4	1.3	0.8	0.8	33	34	21	21
17	Bull Lake	DBr	215	0	215	130	345	Grain & Silage	Beef	111	91	111	22	335	7	134	476	0	0	476	1.4	1.4	1.0	0.9	36	36	25	23
15	Heward	DBr	1265	0	1265	465	1730	Grain	--	885	303	484	121	1793	53	828	2674	0	1	2675	1.5	1.5	1.0	1.0	40	40	27	25
18	McGee	Br	674	0	674	572	1246	Grain	--	283	538	532	0	1353	11	668	2033	0	0	2033	1.6	1.6	1.1	1.1	42	42	28	28
5	Regina	Br	382	0	382	119	501	Grain	--	160	181	191	2	534	43	324	901	0	1	902	1.8	1.8	1.1	1.1	47	46	26	27
21	Cudworth	Bl	349	76	425	178	603	Grain & Silage	Dairy	682	6	169	51	906	9	287	1204	0	105	1309	2.2	2.0	1.5	1.4	56	52	39	37
23	Carragana	Bl	61	0	61	49	110	Grain		66	7	52	0	125	4	94	223	0	4	227	2.1	2.0	1.1	1.1	53	52	29	29
1	Weldon	Bl	488	0	488	83	571	Grain	Beef	282	224	349	145	1000	16	242	1258	0	19	1277	2.2	2.2	1.8	1.5	58	57	45	39
3	Imperial	DBr	504	0	504	0	504	Grain	--	346	220	211	37	814	21	393	1228	0	3	1231	2.4	2.4	1.6	1.5	63	63	42	40
6	Tisdale	Bl	548	39	587	109	696	Grain & Hay	Beef	281	295	380	247	1203	22	481	1706	0	4	1710	2.5	2.5	1.7	1.4	63	63	45	35
13	Semans	DBr	361	17	378	157	535	Grain & Hay	Hogs	180	156	258	198	792	42	612	1446	0	2	1448	2.7	2.7	1.5	1.1	70	70	38	29
2	Calder	Bl	343	87	430	283	713	Grain & Hay	Beef	227	440	283	374	1324	22	595	1941	0	13	1954	2.7	2.7	1.9	1.3	71	70	48	34
12	Humboldt	Bl	79	18	97	83	180	Grain & Hay	Beef	65	112	52	28	257	34	222	513	0	1	514	2.9	2.9	1.4	1.3	74	74	37	33
7	Humboldt	Bl	372	6	378	308	686	Grain	Hogs	221	336	335	57	949	97	929	1975	0	61	2036	3.0	2.9	1.4	1.3	77	74	36	34
19	Maple Creek	Br	109	0	109	12	121	Hay & Silage	Beef	27	8	22	122	179	3	187	369	0	5	374	3.1	3.0	1.5	0.5	80	79	38	12
10	Fergear	Br	55	121	176	0	176	Hay	Dairy	77	2	13	556	648	10	246	904	0	246	1150	6.5	5.1	3.7	0.5	169	133	95	14

Table 5.17a

TABLE 5.17a LIQUID FUEL ENERGY USE ON 20 SASKATCHEWAN FARMS, 1982, PER UNIT AREA

FARM NO.	LOCATION	SOIL ZONE	CULTIVATED AREA (ha)					CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE (GJ)											ENERGY USE PER UNIT AREA (GJ/ha)				FUEL USE PER UNIT AREA (L/ha) (diesel fuel equivalent)			
			ANNUAL CROPS	PERENNIAL CROPS	TOTAL CROPS	SUMMER-FALLOW	TOTAL CULT.			PRODUCTION OPERATIONS: CROP PRODUCTION	PRODUCTION OPERATIONS: SMF & WEED CONTROL	PRODUCTION OPERATIONS: HARVEST & HAULING	PRODUCTION OPERATIONS: OTHER	TOTAL	OTHER FARM USE	TRANSPORTATION	TOTAL FARM USE	WORK DONE FOR OTHERS	WORK SUPPLIED TO OTHERS	TOTAL								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
a		a																								x	y	z
9	Landis	DBr	126	52	178	134	312	Grain & Hay	Sheep	53	21	54	34	162	5	153	320	0	7	327	1.0	1.0	0.5	0.4	27	27	13	11
11	Cochin	Bl	121	40	161	116	277	Grain & Hay	--	34	92	55	7	188	10	86	284	0	0	284	1.0	1.0	0.7	0.7	26	26	18	17
20	Eston	Br	486	0	486	473	959	Grain	--	120	290	244	0	654	21	350	1025	0	3	1028	1.1	1.1	0.7	0.7	28	28	18	18
17	Gull Lake	DBr	209	0	209	150	359	Grain & Silage	Beef	72	102	109	25	308	5	176	489	0	15	504	1.4	1.4	0.9	0.8	36	35	22	20
14	Rossbank	Br	404	0	404	409	813	Grain	--	170	313	219	4	705	14	330	1049	0	4	1052	1.3	1.3	0.9	0.9	33	33	22	22
18	McGee	Br	668	0	668	627	1295	Grain	--	746	0	526	0	1272	0	556	1828	0	0	1828	1.4	1.4	1.0	1.0	36	36	25	25
15	Heward	DBr	1076	0	1076	658	1734	Grain	--	551	627	492	138	1808	61	744	2613	0	0	2613	1.5	1.5	1.0	1.0	39	39	27	25
5	Regina	Br	337	0	337	177	514	Grain	--	158	159	209	13	539	21	211	771	0	8	779	1.5	1.5	1.0	1.0	39	39	27	26
13	Semans	DBr	358	17	375	157	532	Grain & Hay	Hogs	94	121	241	103	559	5	126	690	0	0	690	1.3	1.3	1.1	0.9	34	34	27	22
7	Humboldt	Bl	352	6	358	340	698	Grain	Hogs	206	236	306	7	755	55	981	1791	0	19	1810	2.6	2.6	1.1	1.1	67	66	28	28
16	Kerrobert	Br	300	0	300	308	608	Grain	--	106	370	181	16	673	18	133	824	0	2	826	1.4	1.4	1.1	1.1	35	35	29	28
3	Imperial	DBr	344	0	344	152	496	Grain	--	239	108	195	70	612	5	300	917	123	28	1068	2.2	1.8	1.2	1.1	56	48	32	28
8	Marsden	Bl	1900	0	1900	243	2143	Grain	--	1307	456	1457	0	3220	80	860	4160	0	43	4203	2.0	1.9	1.5	1.5	51	50	39	39
6	Tisdale	Bl	488	103	591	73	664	Grain & Hay	Beef	251	227	334	192	1004	18	518	1540	4	8	1552	2.3	2.3	1.5	1.2	60	60	39	32
19	Maple Creek	Br	109	0	109	12	121	Hay & Silage	Beef	15	9	15	154	193	1	189	383	0	0	383	3.2	3.2	1.6	0.3	82	82	41	8
1	Weldon	Bl	477	0	477	71	549	Grain	Beef	407	152	266	92	917	9	246	1172	0	11	1183	2.2	2.1	1.7	1.5	56	55	43	39
12	Humboldt	Bl	114	16	130	60	190	Grain & Hay	Beef	85	57	96	81	319	41	256	616	0	0	616	3.2	3.2	1.7	1.3	84	84	43	32
21	Cudworth	Bl	391	0	391	212	603	Grain & Silage	Dairy	219	265	226	380	1090	16	295	1401	0	42	1443	2.4	2.3	1.8	1.2	62	60	47	30
2	Calder	Bl	384	124	508	15	523	Grain & Hay	Beef	115	235	269	361	980	66	521	1567	0	11	1578	3.0	3.0	1.9	1.2	78	77	46	31
10	Fangman	Br	55	121	176	0	176	Hay	Dairy	0	58	5	741	804	3	257	1064	0	2	1066	6.1	6.0	4.6	0.4	157	156	118	9

Table 5.17b

TABLE 5.17b LIQUID FUEL ENERGY USE ON 21 SASKATCHEWAN FARMS, 1983, PER UNIT AREA

FARM NO.	LOCATION	SOIL ZONE	CULTIVATED AREA (ha): ANNUAL CROPSa	PERENNIAL CROPS	TOTAL CROPS	SUMMER-FALLOW	TOTAL CULT.	CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE (GJ): PRODUCTION OPERATIONS: CROP PRODUC-TION	SMF & WEED CONTROL	HARVEST & HAULING	OTHER	TOTAL	OTHER FARM USE	TRANS-PORT-ATION	TOTAL FARM USE	WORK DONE FOR OTHERS	SUPPLIED TO OTHERS	TOTAL	ENERGY USE PER UNIT AREA (GJ/ha)				FUEL USE PER UNIT AREA (L/ha) (diesel fuel equivalent)			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
a		b																								x	y	z
9	Landis	DBr	158	0	158	154	312	Grain	Sheep	51	46	70	30	197	8	148	353	0	5	358	1.1	1.1	0.6	0.5	30	29	16	14
11	Cochin	Bl	117	44	161	105	266	Grain & Hay	--	49	59	57	13	178	8	110	296	0	0	296	1.1	1.1	0.7	0.6	29	29	17	16
20	Eston	Br	486	0	486	482	968	Grain	--	197	234	311	3	745	4	216	965	0	1	966	1.0	1.0	0.8	0.8	26	26	20	20
22	Kindersley	Br	518	0	518	0	518	Grain		158	28	230	0	416	9	257	682	0	23	705	1.4	1.3	0.8	0.8	35	34	21	21
14	Mossbank	Br	516	0	516	304	820	Grain	--	209	269	230	4	712	5	349	1066	0	0	1066	1.3	1.3	0.9	0.9	34	34	22	22
17	Gull Lake	DBr	215	0	215	130	345	Grain & Silage	Beef	111	91	111	22	335	7	134	476	0	0	476	1.4	1.4	1.0	0.9	36	36	25	23
16	Kerrobert	Br	322	0	322	304	626	Grain	--	196	206	232	0	634	27	138	799	0	8	807	1.3	1.3	1.0	1.0	33	33	26	26
15	Heward	DBr	1265	0	1265	465	1730	Grain	--	885	303	484	121	1793	53	828	2674	0	1	2675	1.5	1.5	1.0	1.0	40	40	27	25
5	Regina	Br	382	0	382	119	501	Grain	--	160	181	191	2	534	43	324	901	0	1	902	1.8	1.8	1.1	1.1	47	46	28	27
18	McGee	Br	674	0	674	572	1246	Grain	--	283	538	532	0	1353	11	668	2033	0	0	2033	1.6	1.6	1.1	1.1	42	42	28	28
23	Carragana	Bl	61	0	61	49	110	Grain		66	7	52	0	125	4	94	223	0	4	227	2.1	2.0	1.1	1.1	53	52	29	29
7	Humboldt	Bl	372	6	378	306	684	Grain	Hogs	221	336	335	57	949	97	929	1975	0	61	2036	3.0	2.9	1.4	1.3	77	74	36	34
12	Humboldt	Bl	79	18	97	83	180	Grain & Hay	Beef	65	112	52	28	257	34	222	513	0	1	514	2.9	2.9	1.4	1.3	74	74	37	33
19	Maple Creek	Br	109	0	109	12	121	Hay & Silage	Beef	27	8	22	122	179	3	187	369	0	5	374	3.1	3.0	1.5	0.5	80	79	38	12
13	Semans	DBr	361	17	378	157	535	Grain & Hay	Hogs	180	156	258	198	792	42	612	1446	0	2	1448	2.7	2.7	1.5	1.1	70	70	38	29
21	Cudworth	Bl	349	76	425	178	603	Grain & Silage	Dairy	682	6	169	51	908	9	287	1204	0	105	1309	2.2	2.0	1.5	1.4	56	52	39	37
3	Imperial	DBr	504	0	504	0	504	Grain	--	346	220	211	37	814	21	393	1228	0	3	1231	2.4	2.4	1.6	1.5	63	63	42	40
6	Tisdale	Bl	548	39	587	109	696	Grain & Hay	Beef	281	295	380	247	1203	22	481	1706	0	4	1710	2.5	2.5	1.7	1.4	63	63	45	35
1	Weldon	Bl	488	0	488	83	571	Grain	Beef	282	224	349	145	1000	16	242	1258	0	19	1277	2.2	2.2	1.8	1.5	58	57	45	39
2	Calder	Bl	343	87	430	283	713	Grain & Hay	Beef	227	440	283	374	1324	22	595	1941	0	13	1954	2.7	2.7	1.9	1.3	71	70	48	34
10	[illegible]	Br	55	121	176	0	176	Hay	Dairy	77	2	13	556	648	10	246	904	0	246	1150	6.5	5.1	3.7	0.5	169	133	95	14

Total liquid fuel use in production operations ranged from 13 to 118 (16 to 95) L/ha.

Table 5.15a (5.15b) was sorted on column 29 (Table 5.18a (5.18b)). The total liquid use in cropping operations including harvesting and product hauling ranged from 8 to 39 (12 to 40) L/ha.

Table 5.15a (5.15b) was sorted on column 3 (soil zone) with a secondary sort on column 29 (Table 5.19a (5.19b)). The range of total liquid fuel use in cropping operations in the three soil zones in 1982 (1983) was as follows:

black	from 17 to 39 (16 to 39) L/ha.
brown	from 8 to 28 (12 to 28) L/ha;
dark brown	from 11 to 28 (14 to 40) L/ha;

Figure 5.24 shows a comparison of total farm liquid fuel use by soil zone. Figure 5.25 show the comparison of liquid fuel use in cropping operations by soil zone as presented in the text table above.

Liquid Fuel Use by 10-day Period

As part of the fuel log analysis, the year was divided in 36 10-day periods and a remaining 37th period of 5 days and the fuel use in each of these periods was calculated. The analysis was performed for diesel fuel and gasoline separately. The results for each of the 15 farms for which sufficiently detailed fuel logs were kept in 1983 are presented graphically in the case studies (Appendix G1-G23). A summary for the aggregate of the 15 farms is shown in Figures 5.26 (diesel fuel), 5.27 (gasoline) and 5.28 (both fuels combined). Note that the graphs cover the first 36 periods of the year and do not include 2 percent of the diesel fuel and 11 percent of the gasoline used by vehicles for which sufficiently detailed fuel log records were not kept. This fuel use was assigned to period 37. It seems reasonable to assume that this fuel use would have been distributed evenly over the first 36 10-day periods.

The use of diesel fuel through the year shows major peaks in the seeding and harvesting periods, with lesser peaks due to summerfallow and fall tillage. Little diesel fuel is used outside the cropping season.

The use of gasoline (most of which is used in cars and light trucks) is relatively flat throughout the year, with a peak due to swathing and combining superimposed in late summer.

Liquid Fuel Use on Individual Farms

The results for the individual farms are presented in the form of tables and graphs in the case studies (Appendix G1-G23).

Table 5.18a

TABLE 5.18a LIQUID FUEL ENERGY USE ON 20 SASKATCHEWAN FARMS, 1982, PER UNIT AREA

FARM NO.	LOCATION	SOIL ZONE	CULTIVATED AREA (ha)					CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE (GJ)											ENERGY USE PER UNIT AREA (GJ/ha)				FUEL USE PER UNIT AREA (L/ha) (diesel fuel equivalent)			
			ANNUAL CROPS	PERENNIAL CROPS	TOTAL CROPS	SUMMER-FALLOW	TOTAL CULT.			PRODUCTION OPERATIONS								WORK										
										CROP PRODUCTION	SMF & WEED CONTROL	HARVEST & HAULING	OTHER	TOTAL	OTHER FARM USE	TRANSPORTATION	TOTAL FARM USE	DONE FOR OTHERS	SUPPLIED TO OTHERS	TOTAL								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
a		b																								x	y	z
19	Maple Creek	Br	109	0	109	12	121	Hay & Silage	Beef	15	9	15	154	193	1	189	383	0	0	383	3.2	3.2	1.6	0.3	82	82	41	8
10	Pangman	Br	55	121	176	0	176	Hay	Dairy	0	58	5	741	804	3	257	1064	0	2	1066	6.1	6.0	4.6	0.4	157	156	118	9
9	Landis	DBr	126	52	178	134	312	Grain & Hay	Sheep	53	21	54	34	162	5	153	320	0	7	327	1.0	1.0	0.5	0.4	27	27	13	11
11	Cochin	Bl	121	40	161	116	277	Grain & Hay	--	34	92	55	7	188	10	86	284	0	0	284	1.0	1.0	0.7	0.7	26	26	18	17
20	Eston	Br	486	0	486	473	959	Grain	--	120	290	244	0	654	21	350	1025	0	3	1028	1.1	1.1	0.7	0.7	28	28	18	18
17	Gull Lake	DBr	209	0	209	150	359	Grain & Silage	Beef	72	102	109	25	308	5	176	489	0	15	504	1.4	1.4	0.9	0.8	36	35	22	20
13	Semans	DBr	358	17	375	157	532	Grain & Hay	Hogs	94	121	241	103	559	5	126	690	0	0	690	1.3	1.3	1.1	0.9	34	34	27	22
14	Mossbank	Br	404	0	404	409	813	Grain	--	170	313	219	4	705	14	330	1049	0	4	1052	1.3	1.3	0.9	0.9	33	33	22	22
15	Heward	DBr	1076	0	1076	658	1734	Grain	--	551	627	492	138	1808	61	744	2613	0	0	2613	1.5	1.5	1.0	1.0	39	39	27	25
18	McGee	Br	668	0	668	627	1295	Grain	--	746	0	526	0	1272	0	556	1828	0	0	1828	1.4	1.4	1.0	1.0	36	36	25	25
5	Regina	Br	337	0	337	177	514	Grain	--	158	159	209	13	539	21	211	771	0	8	779	1.5	1.5	1.0	1.0	39	39	27	26
7	Humboldt	Bl	352	6	358	340	698	Grain	Hogs	206	236	306	7	755	55	981	1791	0	19	1810	2.6	2.6	1.1	1.1	67	66	28	28
16	Kerrobert	Br	300	0	300	308	608	Grain	--	106	370	181	16	673	18	133	824	0	2	826	1.4	1.4	1.1	1.1	35	35	29	28
3	Imperial	DBr	344	0	344	152	496	Grain	--	239	108	195	70	612	5	300	917	123	28	1068	2.2	1.8	1.2	1.1	56	48	32	28
21	Cudworth	Bl	391	0	391	212	603	Grain & Silage	Dairy	219	265	226	380	1090	16	295	1401	0	42	1443	2.4	2.3	1.8	1.2	62	60	47	30
2	Calder	Bl	384	124	508	15	523	Grain & Hay	Beef	115	235	269	361	980	66	521	1567	0	11	1578	3.0	3.0	1.9	1.2	78	77	48	31
6	Tisdale	Bl	488	103	591	73	664	Grain & Hay	Beef	251	227	334	192	1004	18	518	1540	4	8	1552	2.3	2.3	1.5	1.2	60	60	39	32
12	Humboldt	Bl	114	16	130	60	190	Grain & Hay	Beef	85	57	96	81	319	41	256	616	0	0	616	3.2	3.2	1.7	1.3	84	84	43	32
8	Marsden	Bl	1900	0	1900	243	2143	Grain	--	1307	456	1457	0	3220	80	860	4160	0	43	4203	2.0	1.9	1.5	1.5	51	50	39	39
1	Weldon	Bl	477	0	477	71	549	Grain	Beef	407	152	266	92	917	9	246	1172	0	11	1183	2.2	2.1	1.7	1.5	56	55	43	39

Table 5.18b

TABLE 5.18b LIQUID FUEL ENERGY USE ON 21 SASKATCHEWAN FARMS, 1983, PER UNIT AREA

FARM NO.	LOCATION	SOIL ZONE	CULTIVATED AREA (ha)					CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE (GJ)											ENERGY USE PER UNIT AREA (GJ/ha)				FUEL USE PER UNIT AREA (L/ha) (diesel fuel equivalent)			
										PRODUCTION OPERATIONS																		
			ANNUAL CROPS*	PERENNIAL CROPS	TOTAL CROPS	SUMMER-FALLOW	TOTAL CULT.			CROP PRODUCTION	SMF & WEED CONTROL	HARVEST & HAULING	OTHER	TOTAL	OTHER FARM USE	TRANSPORTATION	TOTAL FARM USE	WORK DONE FOR OTHERS	WORK SUPPLIED TO OTHERS	TOTAL								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
a		b																								x	y	z
19	Maple Creek	Br	109	0	109	12	121	Hay & Silage	Beef	27	8	22	122	179	3	187	369	0	5	374	3.1	3.0	1.5	0.5	80	79	38	12
10	Fangman	Br	55	121	176	0	176	Hay	Dairy	77	2	13	556	648	10	246	904	0	246	1150	6.5	5.1	3.7	0.5	169	133	95	14
9	Landis	DBr	158	0	158	154	312	Grain	Sheep	51	46	70	30	197	8	148	353	0	5	358	1.1	1.1	0.6	0.5	30	29	16	14
11	Cochin	Bl	117	44	161	105	266	Grain & Hay	--	49	59	57	13	178	8	110	296	0	0	296	1.1	1.1	0.7	0.6	29	29	17	16
20	Eston	Br	486	0	486	482	968	Grain	--	197	234	311	3	745	4	216	965	0	1	966	1.0	1.0	0.8	0.8	26	26	20	20
22	Kindersley	Br	518	0	518	0	518	Grain		158	28	230	0	416	9	257	682	0	23	705	1.4	1.3	0.8	0.8	35	34	21	21
14	Rossbank	Br	516	0	516	304	820	Grain	--	209	269	230	4	712	5	349	1066	0	0	1066	1.3	1.3	0.9	0.9	34	34	22	22
17	Gull Lake	DBr	215	0	215	130	345	Grain & Silage	Beef	111	91	111	22	335	7	134	476	0	0	476	1.4	1.4	1.0	0.9	36	36	25	23
15	Heward	DBr	1265	0	1265	465	1730	Grain	--	885	303	484	121	1793	53	828	2674	0	1	2675	1.5	1.5	1.0	1.0	40	40	27	25
16	Kerrobert	Br	322	0	322	306	628	Grain	--	196	206	232	0	634	27	138	799	0	8	807	1.3	1.3	1.0	1.0	33	33	26	26
5	Regina	Br	382	0	382	119	501	Grain	--	160	181	191	2	534	43	324	901	0	1	902	1.8	1.8	1.1	1.1	47	46	28	27
18	McGee	Br	674	0	674	572	1246	Grain	--	283	538	532	0	1353	11	668	2033	0	0	2033	1.6	1.6	1.1	1.1	42	42	28	28
13	Semans	DBr	361	17	378	157	535	Grain & Hay	Hogs	180	156	258	198	792	42	612	1446	0	2	1448	2.7	2.7	1.5	1.1	70	70	38	29
23	Carragana	Bl	61	0	61	49	110	Grain		66	7	52	0	125	4	94	223	0	4	227	2.1	2.0	1.1	1.1	53	52	29	29
12	Humboldt	Bl	79	18	97	83	180	Grain & Hay	Beef	65	112	52	28	257	34	222	513	0	1	514	2.9	2.9	1.4	1.3	74	74	37	33
7	Humboldt	Bl	372	6	378	308	686	Grain	Hogs	221	336	335	57	949	97	929	1975	0	61	2036	3.0	2.9	1.4	1.3	77	74	36	34
2	Calder	Bl	343	87	430	283	713	Grain & Hay	Beef	227	440	283	374	1324	22	595	1941	0	13	1954	2.7	2.7	1.9	1.3	71	70	48	34
6	Tisdale	Bl	548	39	587	109	696	Grain & Hay	Beef	281	295	380	247	1203	22	481	1706	0	4	1710	2.5	2.5	1.7	1.4	63	63	45	35
21	Cudworth	Bl	349	76	425	178	603	Grain & Silage	Dairy	682	6	169	51	908	9	287	1204	0	105	1309	2.2	2.0	1.5	1.4	56	52	39	37
1	Weldon	Bl	488	0	488	83	571	Grain	Beef	282	224	349	145	1000	16	242	1258	0	19	1277	2.2	2.2	1.8	1.5	58	57	45	39
3	Imperial	DBr	504	0	504	0	504	Grain	--	346	220	211	37	814	21	393	1228	0	3	1231	2.4	2.4	1.6	1.5	63	63	42	40

Table 5.19a

TABLE 5.19a LIQUID FUEL ENERGY USE ON 20 SASKATCHEWAN FARMS, 1982, PER UNIT AREA

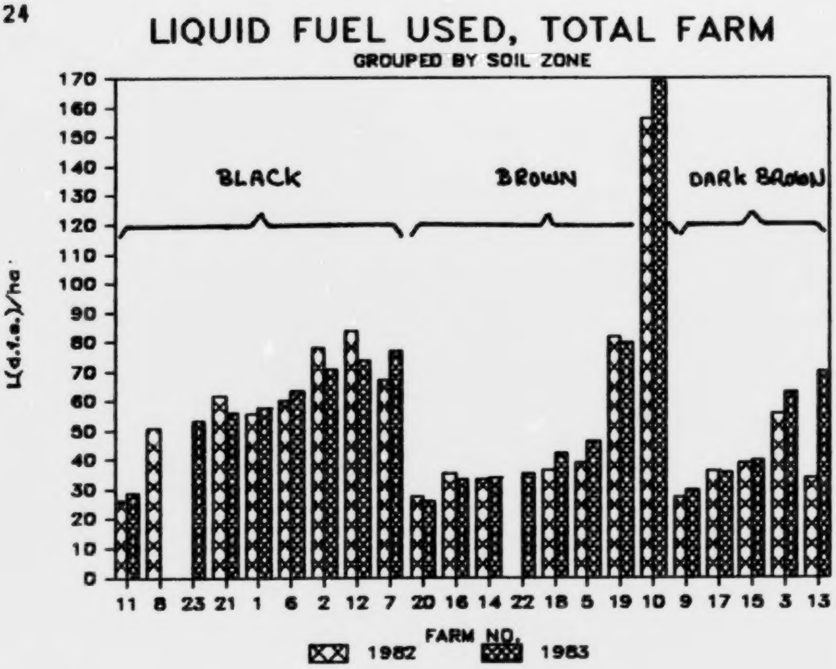
FARM NO.	LOCATION	SOIL ZONE	CULTIVATED AREA (ha): ANNUAL CROPS	PERENNIAL CROPS	TOTAL CROPS	SUMMER-FALLOW	TOTAL CULT.	CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE (GJ): PRODUCTION OPERATIONS: CROP PRODUCTION	SNF & WEED CONTROL	HARVEST & HAULING	OTHER	TOTAL	OTHER FARM USE	TRANSPORTATION	TOTAL FARM USE	WORK DONE FOR OTHERS	SUPPLIED TO OTHERS	TOTAL	ENERGY USE PER UNIT AREA (GJ/ha)				FUEL USE PER UNIT AREA (L/ha) (diesel fuel equivalent)			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
*		*																								8	9	1
11	Cochin	Bl	121	40	161	116	277	Grain & Hay	--	34	92	55	7	188	10	86	284	0	0	284	1.0	1.0	0.7	0.7	26	26	18	17
7	Humboldt	Bl	352	6	358	340	698	Grain	Hogs	206	236	306	7	755	55	981	1791	0	19	1810	2.6	2.6	1.1	1.1	67	66	28	28
21	Cudworth	Bl	391	0	391	212	603	Grain & Silage	Dairy	219	265	226	380	1090	16	295	1401	0	42	1443	2.4	2.3	1.8	1.2	62	60	47	30
2	Calder	Bl	384	124	508	15	523	Grain & hay	Beef	115	235	269	361	980	66	521	1567	0	11	1578	3.0	3.0	1.9	1.2	78	77	48	31
6	Tisdale	Bl	488	103	591	73	664	Grain & Hay	Beef	251	227	334	192	1004	18	518	1540	4	8	1552	2.3	2.3	1.5	1.2	60	60	39	32
12	Humboldt	Bl	114	16	130	60	190	Grain & Hay	Beef	85	57	96	81	319	41	256	616	0	0	616	3.2	3.2	1.7	1.3	84	84	43	32
8	Marsden	Bl	1900	0	1900	243	2143	Grain	--	1307	456	1457	0	3220	80	860	4160	0	43	4203	2.0	1.9	1.5	1.5	51	50	39	39
1	Weldon	Bl	477	0	477	71	549	Grain	Beef	407	152	266	92	917	9	246	1172	0	11	1183	2.2	2.1	1.7	1.5	56	55	43	39
19	Maple Creek	Br	109	0	109	12	121	Hay & Silage	Beef	15	9	15	154	193	1	189	383	0	0	383	3.2	3.2	1.6	0.3	82	82	41	8
10	Pangman	Br	55	121	176	0	176	Hay	Dairy	0	58	5	741	804	3	257	1064	0	2	1066	6.1	6.0	4.6	0.4	157	156	118	9
20	Eston	Br	486	0	486	473	959	Grain	--	120	290	244	0	654	21	350	1025	0	3	1028	1.1	1.1	0.7	0.7	28	28	18	18
14	Mossbank	Br	404	0	404	409	813	Grain	--	170	313	219	4	705	14	330	1049	0	4	1052	1.3	1.3	0.9	0.9	33	33	22	22
18	McGee	Br	668	0	668	627	1295	Grain	--	746	0	526	0	1272	0	556	1828	0	0	1828	1.4	1.4	1.0	1.0	36	36	25	25
5	Regina	Br	337	0	337	177	514	Grain	--	158	159	209	13	539	21	211	771	0	8	779	1.5	1.5	1.0	1.0	39	39	27	26
16	Kerrobert	Br	300	0	300	308	608	Grain	--	106	370	181	16	673	18	133	824	0	2	826	1.4	1.4	1.1	1.1	35	35	29	28
9	Landis	DBr	126	52	178	134	312	Grain & Hay	Sheep	53	21	54	34	162	5	153	320	0	7	327	1.0	1.0	0.5	0.4	27	27	13	11
17	Bull Lake	DBr	209	0	209	150	359	Grain & Silage	Beef	72	102	109	25	308	5	176	489	0	15	504	1.4	1.4	0.9	0.8	36	35	22	20
13	Semans	DBr	358	17	375	157	532	Grain & Hay	Hogs	94	121	241	103	559	5	126	690	0	0	690	1.3	1.3	1.1	0.9	34	34	27	22
15	Howard	DBr	1076	0	1076	658	1734	Grain	--	551	627	492	138	1808	61	744	2613	0	0	2613	1.5	1.5	1.0	1.0	39	39	27	25
3	Imperial	DBr	344	0	344	152	496	Grain	--	239	108	195	70	612	5	300	917	123	28	1068	2.2	1.8	1.2	1.1	56	48	32	28

Table 5.19b

TABLE 5.19b LIQUID FUEL ENERGY USE ON 21 SASKATCHEWAN FARMS, 1983, PER UNIT AREA

FARM NO.	LOCATION	SOIL ZONE	CULTIVATED AREA (ha): ANNUAL CROPS*	PERENNIAL CROPS	TOTAL CROPS	SUMMER-FALLOW	TOTAL CULT.	CROPS	LIVESTOCK	USE OF DIESEL FUEL AND GASOLINE (GJ): PRODUCTION OPERATIONS: CROP PRODUC-TION	SMF & WEED CONTROL	HARVEST & HAULING	OTHER	TOTAL	OTHER FARM USE	TRANS-PORT-ATION	TOTAL FARM USE	WORK DONE FOR OTHERS	SUPPLIED TO OTHERS	TOTAL	ENERGY USE PER UNIT AREA (GJ/ha)				FUEL USE PER UNIT AREA (L/ha) (diesel fuel equivalent)			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
a		b																								x	y	z
11	Cochin	Bl	117	44	161	105	266	Grain & Hay	--	49	59	57	13	178	8	110	296	0	0	296	1.1	1.1	0.7	0.6	29	29	17	16
22	Carragara	Bl	61	0	61	49	110	Grain		66	7	52	0	125	4	94	223	0	4	227	2.1	2.0	1.1	1.1	53	52	29	29
12	Humboldt	Bl	79	18	97	83	180	Grain & Hay	Beef	65	112	52	28	257	34	222	513	0	1	514	2.9	2.9	1.4	1.3	74	74	37	33
7	Humboldt	Bl	372	6	378	308	686	Grain	Hogs	221	336	335	57	949	97	929	1975	0	61	2036	3.6	2.9	1.4	1.3	77	74	36	34
2	Calder	Bl	343	87	430	283	713	Grain & Hay	Beef	227	440	283	374	1324	22	595	1941	0	13	1954	2.7	2.7	1.9	1.3	71	70	48	34
6	Tisdale	Bl	548	39	587	109	696	Grain & Hay	Beef	281	295	380	247	1203	22	481	1706	0	4	1710	2.5	2.5	1.7	1.4	63	63	45	35
21	Cudworth	Bl	349	76	425	178	603	Grain & Silage	Dairy	682	6	169	51	908	9	287	1204	0	105	1309	2.2	2.0	1.5	1.4	56	52	39	37
1	Weldon	Bl	488	0	488	83	571	Grain	Beef	282	224	349	145	1000	16	242	1258	0	19	1277	2.2	2.2	1.8	1.5	58	57	45	39
19	Maple Creek	Br	109	0	109	12	121	Hay & Silage	Beef	27	8	22	122	179	3	187	369	0	5	374	3.1	3.0	1.5	0.5	80	79	38	12
10	Pangman	Br	55	121	176	0	176	Hay	Dairy	77	2	13	556	648	10	246	904	0	246	1150	6.5	5.1	3.7	0.5	169	133	95	14
20	Eston	Br	486	0	486	482	968	Grain	--	197	234	311	3	745	4	216	965	0	1	966	1.0	1.0	0.8	0.8	26	26	20	20
22	Kindersley	Br	518	0	518	0	518	Grain		158	28	230	0	416	9	257	682	0	23	705	1.4	1.3	0.8	0.8	35	34	21	21
14	Mossbank	Br	516	0	516	304	820	Grain	--	209	269	230	4	712	5	349	1066	0	0	1066	1.3	1.3	0.9	0.9	34	34	22	22
16	Kerrobert	Br	322	0	322	306	628	Grain	--	196	206	232	0	634	27	138	799	0	8	807	1.3	1.3	1.0	1.0	33	33	26	26
5	Regina	Br	382	0	382	119	501	Grain	--	160	181	191	2	534	43	324	901	0	1	902	1.8	1.5	1.1	1.1	47	46	28	27
18	McGee	Br	674	0	674	572	1246	Grain	--	283	538	532	0	1353	11	668	2033	0	0	2033	1.6	1.6	1.1	1.1	42	42	28	28
9	Landis	DBr	158	0	158	154	312	Grain	Sheep	51	46	70	30	197	8	148	353	0	5	358	1.1	1.1	0.6	0.5	30	29	16	14
17	Gull Lake	DBr	215	0	215	130	345	Grain & Silage	Beef	111	91	111	22	335	7	134	476	0	0	476	1.4	1.4	1.0	0.9	36	36	25	23
15	Howard	DBr	1265	0	1265	465	1730	Grain	--	885	303	484	121	1793	53	828	2674	0	1	2675	1.5	1.5	1.0	1.0	40	40	27	25
13	Semans	DBr	361	17	378	157	535	Grain & Hay	Hogs	180	156	258	198	792	42	612	1446	0	2	1448	2.7	2.7	1.5	1.1	70	70	38	29
3	Imperial	DBr	504	0	504	0	504	Grain	--	346	220	211	37	814	21	393	1228	0	3	1231	2.4	2.4	1.6	1.5	63	63	42	40

Figure 5.24



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* farm no. 10 is a dairy with a small land base

Figure 5.25

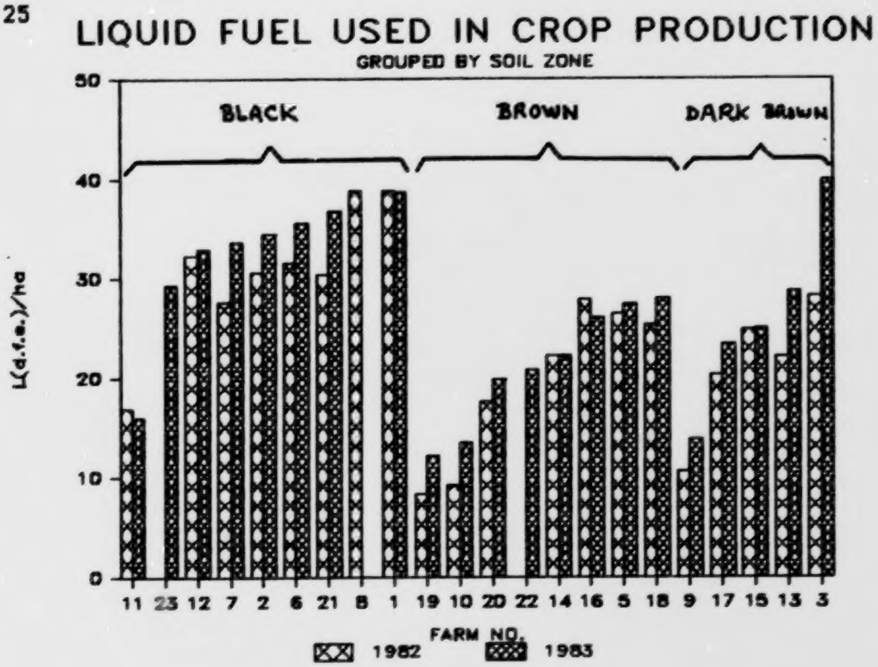
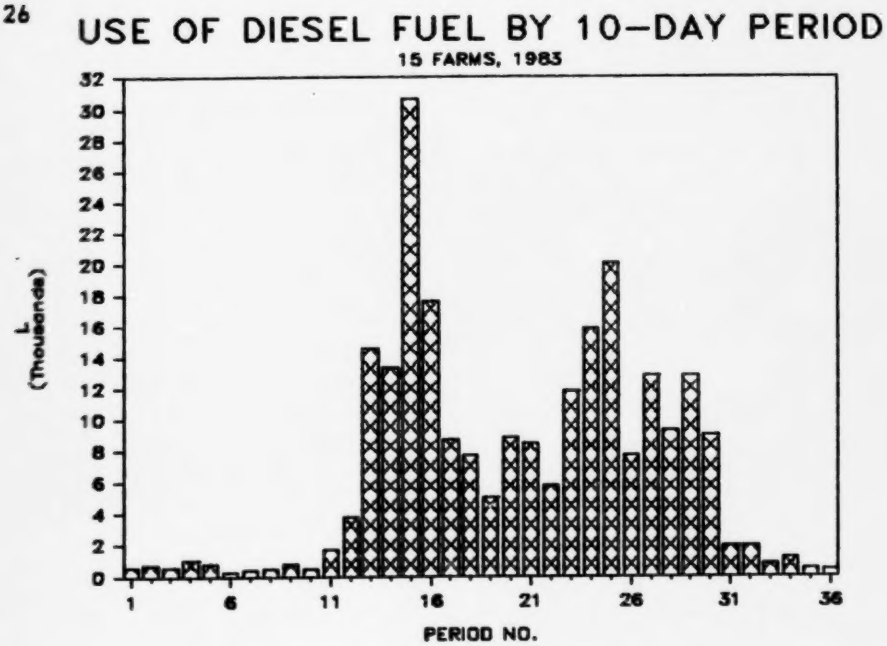

LIQUID FUEL USED IN CROP PRODUCTION
GROUPED BY SOIL ZONE
BLACK
BROWN
DARK BROWN
L(d.f.e.)/ha
0
10
20
30
40
50
11 23 12 7 2 6 21 8 1 19 10 20 22 14 16 5 18 9 17 15 13 3
FARM NO.
1982
1983

Figure 5.26



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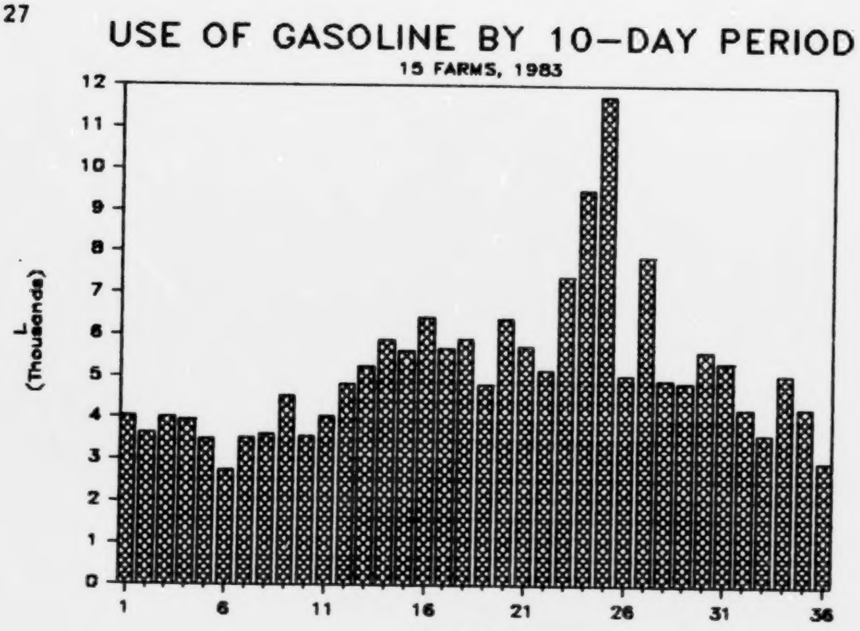
period no. 1 = january 1-10
period no. 2 = january 11-20
period no. 3 = january 21-30
etc.

Figure 5.27



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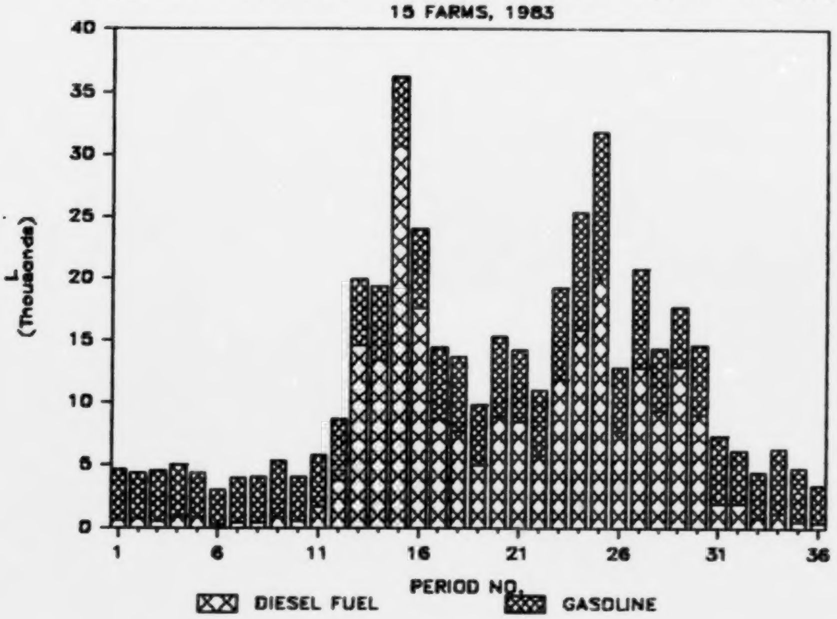
period no. 1 = january 1-10
period no. 2 = january 11-20
period no. 3 = january 21-30
etc.

Figure 5.28 USE OF LIQUID FUEL BY 10—DAY PERIOD



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period no. 1 = january 1-10
period no. 2 = january 11-20
period no. 3 = january 21-30
etc.

5.2.3 *Discussion*

The metering program had several benefits. It created awareness among the cooperators as to the distribution of liquid fuel use on their farms, it gave the cooperators a tool to assess the impact of changes in operating practices on liquid fuel use and it produced benchmark data on liquid fuel use for various operations against which to evaluate changes in operating practices as well as energy use on other farms.

The metering program has shown clearly that liquid fuel use varies greatly among the farms in the FEMP program, not only in quantity but also as to the purpose for which it is used. Opportunities for using liquid fuel more efficiently, therefore, also vary greatly among these farms.

The opportunities for increasing the efficiency of liquid fuel energy use fall mostly into two major areas: transportation and field operations.

Cars and light trucks accounted, on average, for more than 30 percent of total liquid use on the aggregate of FEMP farms (the percentage ranged from less than 20 to more than 60 on individual farms. Fleet efficiencies of cars and light trucks ranged from 10.0 L/100 km (28 mpg) to 23.9 L/100 km (12 mpg). If the fleet efficiencies of cars and light trucks on all FEMP farms were as good as the best fleet efficiency (10.0 L/100 km) in the group, the aggregate annual savings would average 41 percent of fleet fuel use, representing 90,000 L of fuel, worth $35,000 or an average of $1600 per farm. The savings would be equivalent to 17 percent of total liquid fuel use on the aggregate of FEMP farms. This is probably the area of liquid fuel use where savings could be effected most easily by the purchase of energy efficient cars and light trucks as they are replaced over the next several years. We do not know whether the indicated potential fuel savings alone would be a sufficient incentive for the cooperators to replace their present fleet with such efficient vehicles.

Tractors, used mostly in field operations, accounted, on average, for almost 50 percent of total liquid fuel use on the aggregate of FEMP farms. The variability of liquid fuel use in crop production is more the result of farms operating under different soil and climatic conditions and using different cropping practices than of differences in equipment efficiency. In general, two kinds of opportunities exist to improve the efficiency of liquid fuel energy use of tractors. Direct savings can result from operating the tractor more efficiently by a number of well-known techniques or by reducing the number of tillage operations. The efficiency of liquid fuel use can also be improved by producing more crop for the same fuel input. Examples of such opportunities are discussed in more detail in Chapter 1 of this report as well as in the Year III Main Report of the FEMP program.

5.3 HEATING FUELS AND ELECTRICITY

5.3.1 Methods

Introduction

Heating fuels (heating oil, propane, natural gas, wood and some electricity) are used for space and water heating in homes, shops and livestock buildings and for grain drying. The remainder of the electricity is used in homes for lights and appliances; outside for yard lights, blockheaters, livestock watering bowls and grain dryer fans; in shops for lights, welders and small motors; and in livestock buildings for fans and grinding feed.

All electricity used inside a building contributes to meeting its space heating needs, directly or indirectly. Estimating the space heating needs of a building by adding all heat inputs to the building over the year requires, among other things, knowledge of the electricity used inside the building. The presence of only one electrical meter on most of the cooperating farms, makes it difficult to estimate the contribution electricity makes to space heating in the various buildings accurately.

In the spring of 1982, the Saskatchewan Power Corporation (SPC) agreed to take on responsibility for the analysis of electric energy use on the 21 farms then in the program. This decision was reversed later in the year. However, at that time, SPC made available to the FEMP a number of kilowatt hour-meters for such an analysis. For a number of reasons (such as time and budget considerations and the relatively limited information the additional metering, as proposed, would provide), this part of the program was not completed.

Notwithstanding this and other limitations of the accuracy and completeness of the data (to be explained below), an attempt was made to estimate the energy efficiency of heated buildings and to pinpoint those which might benefit from a complete energy audit and subsequent upgrading of their energy efficiency.

Data collection

The quantities of heating fuels and electricity purchased in 1980, 1981, 1982 and 1983 were provided by the cooperators from their records. (Wood, used on a few farms, was obtained by the cooperators locally at zero out-of-pocket cost.) More detailed records of the use of electricity and natural gas on the cooperators' farms were obtained from the Saskatchewan Power Corporation. It should be noted that the annual billing periods used by SPC often do not coincide with the calendar year and vary from farm to farm. Therefore, the reported electrical energy use on most of the 23 farms does not coincide in time with the use of heating fuels reported by the cooperators for the calendar year.

Other information was obtained by interviewing the cooperators. This included information on the age, size, construction, heated floor area and heating systems of buildings; information on the power demand and estimated annual hours of use of all electricity using devices on the farm; and changes made to buildings and equipment or their use during the four-year period of the FEMP.

The heating degree days (<18 Cel) for the locations of the cooperators' farms for each of the years 1980, 1981, 1982 and 1983 were estimated from temperature records for neighbouring communities published by Environment Canada.

Conversion efficiencies were assumed to be 1.0 for electricity and 0.6 for all other energy inputs.

Estimation of energy use

The annual use of heating oil, propane, natural gas and wood was distributed to the various buildings and operations according to information provided by the cooperators.

With few exceptions, the annual use of electricity was distributed to the various buildings and operations partly according to estimates provided by the cooperators, partly based on a number of assumptions, as follows:

- First, 2000 kW.h/a per household was arbitrarily assigned to general outdoor uses such as yard lights and blockheaters, except on farm 11, where none was so assigned.

- Second, electrical energy use by outdoor production equipment, such as livestock watering bowls, feed grinders and grain dryers was estimated from information provided by the cooperator.

- Next, one of the following three options was applied:
  - If there were no electrically heated livestock buildings, the balance of the electrical energy used was attributed to the house.
  - If there was an electrically heated house, as well as electrically heated livestock buildings, 33000 kW.h/a was assigned to the house and the balance of the electrical energy used was attributed to the livestock buildings.
  - If the house was not electrically heated, but there were electrically heated livestock buildings, the electrical energy used by the latter was estimated from information provided by the cooperator, and the balance was attributed to home space and water heating.

From the foregoing information the gross average annual energy use of each building in the period 1980-1983 was calculated, as well as the net average annual energy use (after application of the furnace efficiencies).

Finally, division of the net average annual energy use by the average annual heating degree days in the period 1980-83 and by the heated floor area (m2) provides an energy efficiency index (kJ/(Cel.d.m2)) for each heated building. This index is independent of the local climate and of the size of the building. We included the floor areas of heated basements in the total heated floor areas.

An additional complication was created by poorly documented changes to the buildings and their heating systems during the FEMP program.

5.3.2 Results

Considering the unreliability of the data the following results should be regarded as first approximations.

Farm Residences

Table 5.20 compares the estimated energy efficiencies of the 28 residences on the 22 farms in the program at the end of 1983. Note that the heated floor areas include heated basements, where present. The gross energy use includes the energy value of all energy inputs to the buildings. In calculating the energy efficiencies, the conversion efficiency of energy inputs was assumed to be 1.0 for electricity and 0.6 for all other energy inputs.

For the 19 residences for which the data were judged to be reasonably reliable the results are summarized in Table 5.21. The age distribution of these residences is graphically presented in Figure 5.29. There appear to be two fairly distinct age groups. One group was built in the last ten years. The average age of the remainder is 48 years. Figure 5.30 shows the gross energy use by age and Figure 5.31 shows the energy efficiency by age. The energy efficiencies range from 57 to 207 kJ/(Cel.d.m2) and average 110 kJ/(Cel.d.m2).

Livestock Buildings

The two dairies (Farms 10 and 21) and the two hog operations (Farms 7 and 13) are substantial users of energy, mostly in the form of electricity with some propane being used in a few cases. Some of the cooperators on these farms have already taken advantage of the energy audit provided by the Energy Bus and have taken conservation measures such as installing air-to-air heat exchangers. Without separate meters for monitoring the use of electricity or a further Energy Bus audit, it is difficult to estimate what the effect of such conservation measures has been.

Grain Drying

Grain drying was practiced one or more years during the program by 5 of the cooperators. When averaged over the 4-year period, the quantities of fuel used for this purpose were equivalent to or less than those required to heat an average house for a year. Several of these five cooperators have now using air drying systems.

Shops

Six of the cooperators used substantial quantities of fuel

Table 5.20

Estimated Energy Efficiencies of 28 Residences on 22 Farms

Farm no.	Building type	Year built	Heated floor area (m2)	Average gross energy use 1980-1983 (GJ/a)	Estimated energy efficiency 1980-1983 (kJ/(Cel.d.m2)	Comments
1	house	1973	208	160	91	
2	house	1959	178	205	138	
2	trailer	1975	110	150	176	
3	house	1976	260	300	140	
5	house	1980	298	172	97	Currently 86 kJ/(Cel.d.m2), a 20% reduction from 1980-82
6	house 1	1926	200	162	103	
6	house 2	1942	204	172	110	
7	house 1	1937	214	247	143	
7	house 2	1962	208	188	106	
8	house	1920	245	631	277	Data unreliable
9	house	1936	268	230	100	
10	house	1978	228	119	97	Assumed, cannot separate house from dairy barn
11	house 1	1979	168	151	96	
11	house 2	1920	46	90	207	
11	house 3	1980	112	85	78	
12	house	1946	238	180	95	1984 audit shows a 43 % reduction after recent retrofit
13	house	1978	230	119	90	Assumed, cannot separate house from hog barns
14	house	1975	250	126	93	
15	house	1975	286	177	110	
16	house	1916	294	187	87	
17	house	1907	180	156	124	Replaced with energy-efficient house in late 1983
18	house	1981	278	232	111	
19	trailer	1968	58	113	303	
20	house	1980	279	118	57	
21	trailer	1976	88			Data too unreliable to make estimate
21	house	1982	260			Occupied late 1982, data unreliable
22	house	1983	236			Energy-efficient, occupied late 1983, no data available
23	house	1955	160			Not occupied in winter

Table 5.21

Estimated Energy Efficiencies of 19 Selected Residences on 15 Farms

Farm no.	Building type	Year built	Age in 1983	Heated floor area (m2)	Average gross energy use 1980-1983 (GJ/a)	Average gross energy use per unit area (GJ/(m2.a))	Estimated energy efficiency 1980-1983 (kJ/(Cel.d.m2)	Energy efficiency as % of average (%)	Energy efficiency as % of best (%)
20	house	1980	3	279	118	0.42	57	52	100
11	house 3	1980	3	112	85	0.76	78	71	137
16	house	1916	67	294	187	0.64	87	79	153
1	house	1973	10	208	160	0.77	91	83	160
14	house	1975	8	250	126	0.50	93	85	163
12	house	1946	37	238	180	0.76	95	87	167
11	house 1	1979	4	168	151	0.90	96	87	168
5	house	1980	3	298	172	0.58	97	88	170
9	house	1936	47	268	230	0.86	100	91	175
6	house 1	1926	57	200	162	0.81	103	94	181
7	house 2	1962	21	208	188	0.90	106	97	186
15	house	1975	8	286	177	0.62	110	100	193
6	house 2	1942	41	204	172	0.84	110	100	193
18	house	1981	2	278	232	0.83	111	101	195
17	house	1907	76	180	156	0.87	124	113	218
2	house	1959	24	178	205	1.15	138	126	242
3	house	1976	7	260	300	1.15	140	128	246
7	house 1	1937	46	214	247	1.15	143	130	251
11	house 2	1920	63	46	90	1.96	207	189	363
total				4169	3338				
average		1955	28	219	176	0.87	110		

Figure 5.29

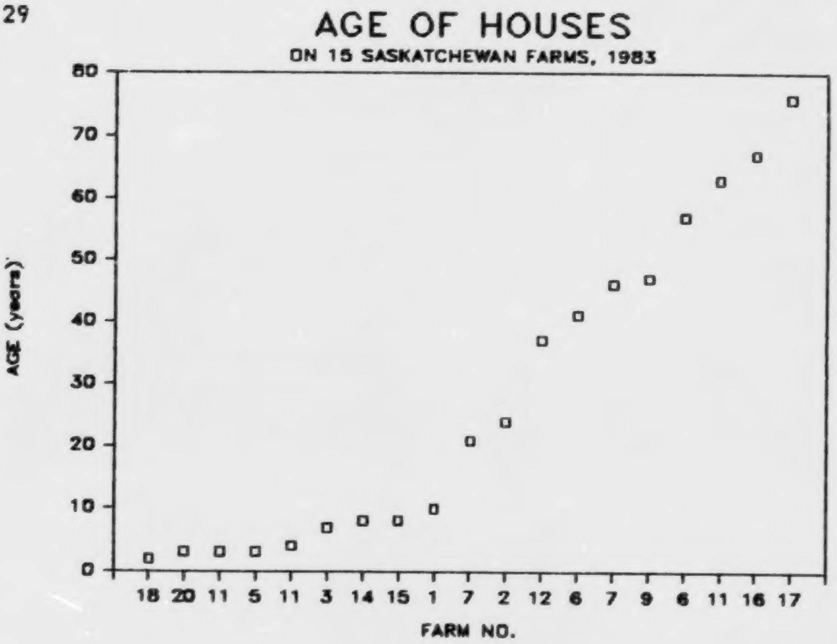

AGE OF HOUSES
ON 15 SASKATCHEWAN FARMS, 1983
AGE (years)
80
70
60
50
40
30
20
10
0
18
20
11
5
11
3
14
15
1
7
2
12
6
7
9
6
11
16
17
FARM NO.

Figure 5.29 ENERGY EFFICIENCY OF HOUSES VS. AGE

ON 15 SASKATCHEWAN FARMS, 1983

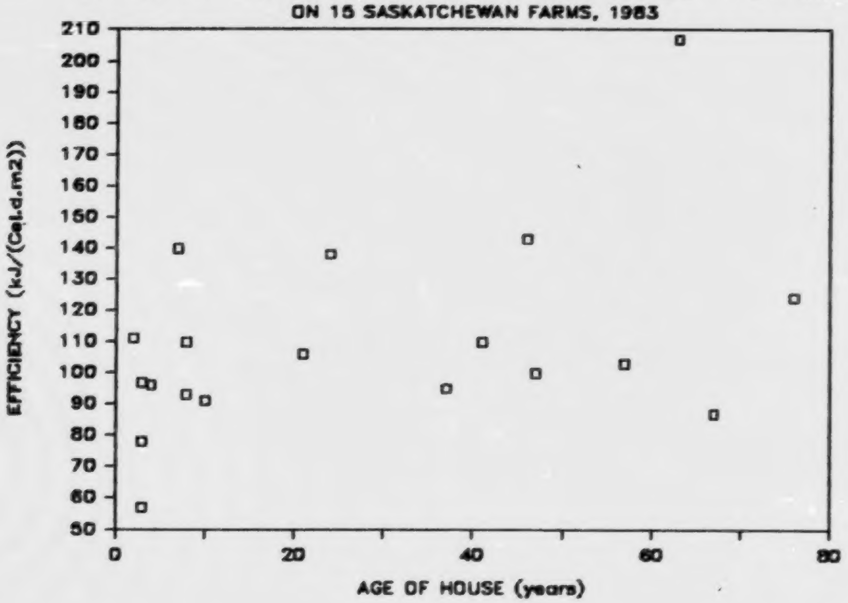
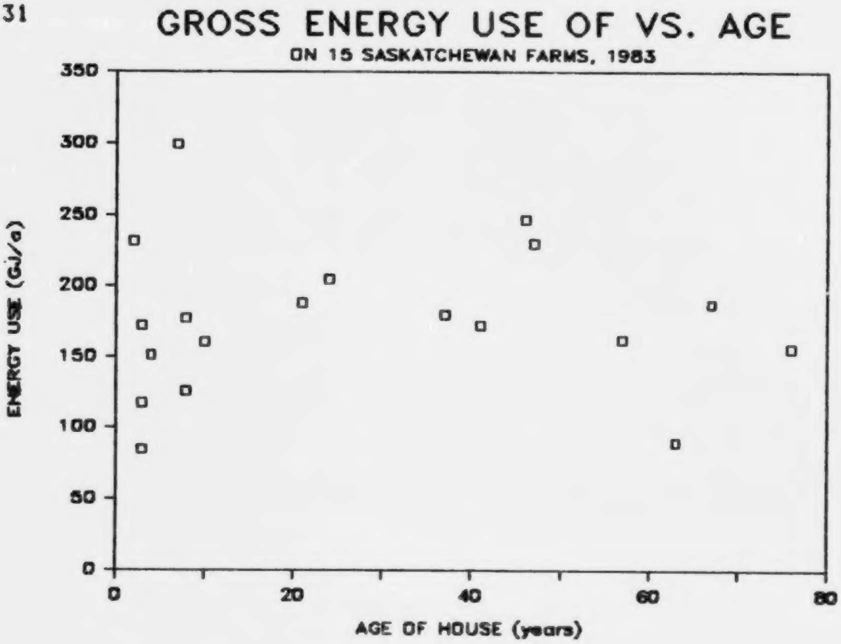


Figure 5.31


GROSS ENERGY USE OF VS. AGE
ON 15 SASKATCHEWAN FARMS, 1983
ENERGY USE (GJ/a)
AGE OF HOUSE (years)
0
50
100
150
200
250
300
350
0
20
40
60
80

(similar to those required to heat an average house) to heat their shops, even though the heated floor areas of the shops tended to be less than those of an average house and the hours they were occupied may be assumed to have been less than those of a house.

5.3.3 Discussion

If 18 of the 19 residences listed in Table 5.21 were retrofitted or replaced with residences as efficient as the best one in the group (57 kJ/(Cel.d.m2)), then a total of approximately 1500 GJ (46 percent of the energy used in 1983), worth approximately $11000 (an average of $600 per farm, but ranging from $400 to $1200 per farm), would be saved annually.

Assuming that another 60,000 farm residences in Saskatchewan have the same potential for improvement of their energy efficiency, then their combined potential for saving energy is $36 million per annum.

Since the annual dollar savings alone may not provide a reasonable payback of the cost of a major retrofit or of replacing an existing residence with a new one, it is important that the opportunity to upgrade the energy efficiency of an existing residence or to build it into a new one not be missed when, for other reasons, extensive modifications are made to an existing residence or a new one is built. The continued provision of incentives would ensure that such energy efficiency improvements are made as these opportunities arise.

It would be useful to do an energy audit of all the houses in the FEMP program using a computer program such as HOTCAN, to determine its value in helping farmers to make decisions on upgrading the energy efficiency of their houses as well as to provide a check on our results.

It is interesting to note that the dollar savings per gross GJ saved depend on the fuel being used and at current fuel prices range from $10.60/GJ for electricity to $8.60/GJ for oil and $3.50 for natural gas. The costs of these fuels per net GJ supplied to meet the actual heat load vary with their conversion efficiency and range as follows:

	cost per net GJ heat load supplied ($/GJ)				
conversion efficiency	0.6	0.7	0.8	0.9	1.0
heating oil	14.33	12.29	10.75	9.56	8.60
natural gas	5.83	5.00	4.38	3.89	3.50
electricity					10.60

It is easy to see why from the individual's point of view electric heating is seen as an economic alternative to oil heating at a conversion efficiency of 0.6 or 0.7 and why natural gas heating seems even more attractive. However, such comparisons don't take into consideration the capital costs which would be incurred in expansion of the power generation and transmission system or the natural gas distribution system if switching to these alternate fuels were to take place on a large scale. If 60,000 farm houses were converted to electric space heating, and assuming an average heated area of 219 m2 per house, an average energy efficiency of 110 kJ/(Cel.dd.m2), one third of the heat load being met by sources such as waste heat of electrical appliances and hot water allowed to cool inside the house, average climatic conditions of 6000 Cel.d per annum, and an annual load factor of 0.17, then the annual peak load on the system would increase by more than 1000 MW. At an estimated cost of $2 million dollar per megawatt for expansion of generation and transmission capacity, the capital cost of system expansion would be $2 billion or $33,000 per farm residence converted to electricity. Assuming a servicing cost of 15 percent per annum for the capital invested, the cost per farm residence would be $5000 per annum or an additional $35 per net GJ heat load, equivalent to an additional $0.12 per kilowatt hour. If these additional system costs were equally shared by all users, the average cost per kilowatt hour would rise by approximately $0.03, i.e. it would approximately double. This back-of-the-envelope calculation shows that in proposing alternatives to current fuel use it is important to look at the costs and benefits of system changes.

For livestock buildings, the energy bus program is probably the best tool available for analyzing current energy use and making recommendations for improvements.

Without some economical way to provide farmers with timely feedback on the distribution of electrical energy use on their farms, it is difficult to determine quantitatively the opportunities for reducing electrical energy use. We estimate that on most farms the major opportunities for reducing electrical energy use are in one or more of three categories: space heating, hot water heating, and block heaters. It would be useful to investigate (1) whether electrical metering equipment and billing practices being used in other countries provide more detailed and more frequent feedback to the consumer than those of Canadian utilities and (2) what technology is readily available or could be developed to provide the desired feedback at reasonable cost.

5.4 PLANT NUTRIENTS

5.4.1 Methods

The quantities of nitrogen and phosphate fertilizers purchased in 1980, 1981, 1982 and 1983 were provided by the cooperators from their records. It was assumed that the fertilizers were applied in the year in which they were purchased.

The quantities of fertilizer included in the example of each farm's cropping practices for 1983 (see the case studies for each farm) may differ from the quantities reported purchased in 1983, as the former include fertilizers applied in the fall of 1982 for the 1983 crop, but exclude fertilizers applied in the fall of 1983 for the 1984 crop.

The energy values of the various fertilizer products used were derived from data published by Southwell and Rothwell (1978)*, supplemented by estimates by the author for fertilizers not listed there. The energy values used in this study are the following:

	MJ/kg N	MJ/kg P2O5
10-34-0	83	11
11-48-0	83	11
11-51-0	83	11
11-55-0	83	11
23-24-0	73	11
27-26-0	78	11
27-27-0	78	11
21-0-0	59	
28-0-0	73	
34-0-0	73	
46-0-0	73	
82-0-0	58	

For each farm the quantitities and energy content of the N and P2O5 used were calculated, as well as their use per unit area.

5.4.2 Results

Table 5.22a (5.22b) shows a summary of the nitrogen and phosphate fertilizers purchased and, we presume, applied on the 20 (22) farms in 1982 (1983), respectively.

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* Southwell, P.H. and T.M. Rothwell, June 1978. Energy Costs and Output/ Input Ratios for Ontario Agriculture, School of Engineering, University of Guelph.

Table 5.22a

Fertilizer Use on 20 Saskatchewan Farms, 1982

FARM NO.	LOCATION	CULT. (ha)	CROPS	LIVESTOCK	FERTILIZERS						
					kg N	kg P205	GJ N	GJ P205	kg N/ha	kg P205/ha	GJ/ha
1	Weldon	549	Grain	Beef	23580	14280	1445	157	43.0	26.0	2.9
2	Calder	522	Grain & Hay	Beef	18631	8800	1125	97	35.7	16.9	2.3
3	Imperial	496	Grain & Hay	--	7676	6720	484	74	15.5	13.5	1.1
5	Regina	514	Grain	--	11217	6893	749	76	21.8	13.4	1.6
6	Tisdale	663	Grain & Hay	Beef	33559	17034	2158	187	50.6	25.7	3.5
7	Humboldt	699	Grain	Hogs	3510	5610	268	62	5.0	8.0	0.5
8	Marsden	2144	Grain	--	126613	52800	7646	581	59.1	24.6	3.8
9	Landis	310	Grain & Hay	Sheep	0	0	0	0	0.0	0.0	0.0
10	Pangman	175	Hay	Dairy	1380	0	101	0	7.9	0.0	0.6
11	Cochin	267	Grain & Hay	--	385	1785	32	20	1.4	6.7	0.2
12	Humboldt	189	Grain & Hay	Beef	36	165	3	2	0.2	0.9	.0
13	Semans	532	Grain & Hay	Hogs, Beef	8033	7331	602	81	15.1	13.8	1.3
14	Mossbank	813	Grain	--	7989	10588	541	116	9.8	13.0	0.8
15	Heward	1737	Grain	--	47110	29046	3505	320	27.1	16.7	2.2
16	Kerrobert	608	Grain	--	1489	6903	124	76	2.4	11.4	0.3
17	Gull Lake	350	Grain & Silage	Beef	2345	3789	181	42	6.7	10.8	0.6
18	McGee	1294	Grain	--	8303	15249	639	168	6.4	11.8	0.6
19	Maple Creek	120	Hay & Silage	Beef	0	0	0	0	0.0	0.0	0.0
20	Eston	958	Grain	--	6509	11781	449	130	6.8	12.3	0.6
21	Cudworth	602	Grain & Silage	Dairy	9040	7838	569	86	15.0	13.0	1.1

Table 5.22b

Fertilizer Use on 22 Saskatchewan Farms, 1983

FARM NO.	LOCATION	CULT. (ha)	CROPS	LIVESTOCK	FERTILIZERS kg N	kg P205	GJ N	GJ P205	kg N/ha	kg P205/ha	GJ/ha
1	Weldon	571	Grain	Beef	27272	13938	1657	153	47.8	24.4	3.2
2	Calder	713	Grain & Hay	Beef	15071	7000	909	77	21.1	9.8	1.4
3	Imperial	504	Grain	--	16178	9724	991	107	32.1	19.3	2.2
5	Regina	501	Grain	--	10641	8115	794	89	21.2	16.2	1.8
6	Tisdale	696	Grain & Hay	Beef	35071	12270	2241	135	50.4	17.6	3.4
7	Humboldt	686	Grain	Hogs	2865	4310	218	47	4.2	6.3	0.4
8	Marsden	1219	Grain	--	64929	38897	4824	428	53.3	31.9	4.3
9	Landis	312	Grain	Sheep	1062	2583	82	28	3.4	8.3	0.4
10	Pangman	176	Hay	Dairy	0	0	0	0	0.0	0.0	0.0
11	Cochin	266	Grain & Hay	--	549	2545	46	28	2.1	9.6	0.3
12	Humboldt	180	Grain & Hay	Beef	0	0	0	0	0.0	0.0	0.0
13	Semans	535	Grain & Hay	Hogs	16573	8448	1234	93	31.0	15.8	2.5
14	Mossbank	820	Grain	--	11035	12536	718	138	13.5	15.3	1.0
15	Heward	1730	Grain	--	40545	29098	2509	320	23.4	16.8	1.6
16	Kerrobert	628	Grain	--	1388	6942	115	76	2.2	11.1	0.3
17	Gull Lake	345	Grain & Silage	Beef	6079	4790	455	53	17.6	13.9	1.5
18	McGee	1246	Grain	--	9131	15416	613	170	7.3	12.4	0.6
19	Maple Creek	121	Hay & Silage	Beef	0	0	0	0	0.0	0.0	0.0
20	Eston	968	Grain	--	3876	11104	307	122	4.0	11.5	0.4
21	Cudworth	603	Grain & Silage	Dairy	7079	8915	489	98	11.7	14.8	1.0
22	Kindersley	518	Grain	--	61217	9979	4489	110	118.2	19.3	8.9
23	Caragana	110	Grain	--	1643	2145	121	24	14.9	19.5	1.3

5.4.3 Discussion

The amount of energy embodied in the fertilizers applied on FEMP farms in 1983 averaged 1.86 GJ per cultivated hectare (ranging from 0.00 to 8.84 GJ/ha), mostly in the form of nitrogen. This was slightly less than the amount of energy embodied in all liquid fuels used in the same period, which averaged 1.94 GJ per cultivated hectare (ranging from 1.12 to 6.53 GJ/ha). On average, the ratio of fertilizer energy to liquid fuel energy used was 0.96 (ranging from 0.00 to 6.45). In dollar terms, fertilizer inputs cost, on average, $25.34/ha as compared to $19.89/ha for liquid fuels.

Whereas liquid fuel use is not expected to increase significantly in the future and may well decrease, fertilizer use could increase significantly as soils are becoming increasingly depleted of their original nutrient content. Thus, fertilizer may soon surpass liquid fuels as the major energy input on FEMP farms. It already is the larger input in dollar terms. Using fertilizer efficiently not only conserves dollars, it conserves energy.

Although an increase in fertilizer use often results in greater net revenue because the resulting increase in yield more than offsets the increase in fertilizer cost, this is not always the case.

If fertilizer is applied beyond a certain optimum rate, crop yield may actually be reduced below the maximum possible. The resulting reduction in revenue, together with the unnecessary expense of the excess fertilizer, have a double effect on net revenue. If in doubt as to the optimum quantity of fertilizer to be used, it might therefore be prudent to err on the side of applying too little rather than too much.

Some areas of a field often require more fertilizer than others. If fertilizer is applied at a uniform rate to such fields, than either too much may be applied to areas which require less, thus reducing yields there or too little may be applied to areas which require more, thus resulting in less than optimum yields there.

Calculation of the optimum rate of fertilizer application based on adequate soil testing for nutrients and the use of variable rates of application of fertilizer within fields which require them would ensure that the energy embodied in fertilizer is used to produce the optimum yield. Rates above the optimum waste both dollars and energy.

One way to reduce the energy use involved in the application of chemical nitrogen fertilizer is by meeting all or part of the nitrogen requirements by growing nitrogen fixing crops in the rotation. This has additional benefits in terms of slowing down and perhaps even reversing soil degradation.

The energy and dollar implications of fertilizer use are discussed in more detail in Chapter 1 of this report as well as in the Year III Main Report of the FEMP program.

5.5 HERBICIDES

5.5.1 Methods

The quantities of herbicides used in 1983 were obtained from the cooperators for use in the description of their cropping practices in the case studies for the individual farms. Herbicide data was not collected for the earlier years of the program since it was judged not to be a significant energy input (although a very significant cost input). This judgement was not entirely accurate as we are about to show.

The energy values of the various herbicides used were derived from data published by Southwell and Rothwell (ibid.), supplemented with estimates by the author for herbicides not listed there. The energy values used in this study are as follows:

product	MJ/kg AI (AI = active ingredient)
avadex	231
avenge	461
banvel	402
buctril	295
dyvel	184
glean	461
heritage	375
hoegrass	328
mataven	461
mcpa	129
mcpa ester	202
pardner	461
poast	461
roundup	461
sabre	295
sencor	344
stampede	328
sweep	414
treflan	375
2,4-D amine	82
2,4-D ester	202

5.5.2 Results

Table 5.23 shows a summary of the herbicides applied on 22 farms in 1983.

5.5.3 Discussion

Although the energy embodied in herbicides applied on FEMP farms in 1983 averaged only 0.17 GJ/ha (ranging from 0.00 to 0.37 GJ/ha), as compared to 1.94 GJ/ha for liquid fuels and 1.86 GJ/ha for fertilizers,

Table 5.23

Herbicide Use on 22 Saskatchewan Farms, 1983

FARM NO.	LOCATION	CULT. (ha)	CROPS	LIVESTOCK	HERBICIDES			
					kg AI	GJ	kg AI/ha	GJ/ha
1	Weldon	571	Grain	Beef	476	118	0.83	0.21
2	Calder	713	Grain & Hay	Beef	258	46	0.36	0.06
3	Imperial	504	Grain & Hay	--	331	85	0.66	0.17
5	Regina	501	Grain	--	352	77	0.70	0.15
6	Tisdale	696	Grain & Hay	Beef	949	254	1.36	0.36
7	Humboldt	686	Grain	Hogs	352	74	0.51	0.11
8	Marsden	1219	Grain	--	709	211	0.58	0.17
9	Landis	312	Grain & Hay	Sheep	4	1	0.01	.00
10	Pangman	176	Hay	Dairy	0	0	0.00	0.00
11	Cochin	266	Grain & Hay	--	0	0	0.00	0.00
12	Humboldt	180	Grain & Hay	Beef	35	5	0.19	0.03
13	Semans	535	Grain & Hay	Hogs, Beef	385	83	0.72	0.16
14	Mossbank	820	Grain	--	461	88	0.56	0.11
15	Heward	1730	Grain	--	974	302	0.56	0.17
16	Kerrobert	628	Grain	--	337	84	0.54	0.13
17	Gull Lake	345	Grain & Silage	Beef	149	53	0.43	0.15
18	McGee	1246	Grain	--	1369	339	1.10	0.27
19	Maple Creek	121	Hay & Silage	Beef	0	0	0.00	0.00
20	Eston	968	Grain	--	853	222	0.88	0.23
21	Cudworth	603	Grain & Silage	Dairy	217	54	0.36	0.09
22	Kindersley	518	Grain	--	388	138	0.75	0.27
23	Caragana	110	Grain	--	35	9	0.32	0.08

herbicides were, nevertheless, a significant energy input, ranking with heating oil (0.14 GJ/ha) and electricity (0.35 GJ/ha).

In terms of cost, herbicides were, on average, the third largest energy input at $13.40 per cultivated hectare (ranging from $0.00/ha to $49.44/ha) on FEMP farms in 1983, after fertilizers at $25.34 and liquid fuels at $19.89.

Efforts to reduce herbicide use could result in very significant cost savings and, relatively, much smaller energy savings. An example is given in Chapter 1 of this report: winter wheat grown with minimum tillage methods required substantially less herbicide than spring wheat when both were grown as crops in stubble.

5.6 SUMMARY OF ENERGY INPUTS

For each of the cooperators' farms summaries of all energy inputs, in physical units and in energy terms, were prepared for the years 1982 and 1983. (The data provided by the cooperators for 1980 and 1981 could not be verified and was judged to be misleading). Results for each farm are presented in the form of tables and graphs in the case studies (Appendix G1-G23).

Comparative results for all 22 farms in 1983 are presented in Table 5.24 (7 pages!). The table includes the following sections:

A1 - energy inputs (physical units/a)
- the right-most column shows unit costs of all energy inputs except herbicides in 1984 dollars (these unit costs are used below)

A2 - average unit cost in 1984 dollars for each farm of the mix of herbicides used in 1983
B - energy values (MJ/unit; variable for plant nutrients) used in calculating energy inputs
C - cultivated areas (ha)
D - "target outputs" (see explanation on p. 5.101) in thousands of dollars (k$)

E1 - energy inputs (GJ/a) (calculated from A and B)
E2 - energy inputs (% of total) (calculated from E1)
E3 - energy inputs per unit of cultivated area (GJ/ha) (calculated from C and E1)
E4 - energy inputs (GJ/a) as % of total (calculated from E3) (see note below table E5 re combination of liquid fuels and heating fuels in two groups)
E5 - energy inputs per unit of cultivated area (GJ/ha) (calculated from C and E4) (see Figure 5.32)

F1 - the fractions of the energy inputs used in farm production
F2 - the fractions of the energy inputs used in transportation (cars and light trucks, as defined above (p. 5.?)).
F3 - the fractions of the energy inputs used for "other uses" (including farmstead, home heating, fuel supplied to others, and custom work done for others)

G1 - energy inputs used in farm production (physical units) (calculated from A and F1)
G2 - energy inputs used in transportation (physical units) (calculated from A and F2)
G3 - energy inputs used for "other uses" (physical units) (calculated from A and F3)
G4 - energy inputs used in farm production (GJ/ha) (calculated from C and G1, with liquid fuels and heating fuels combined in two groups) (see Figure 5.33)
G5 - energy inputs used in transportation (GJ/ha) (calculated from C and G2, with liquid fuels and heating fuels combined in two groups)
G6 - energy inputs used in "other uses" (GJ/ha) (calculated from C and G3, with liquid fuels and heating fuels combined in two groups)

H1 - cost per unit of cultivated area of energy inputs used in production ($/ha) (calculated from C, G1 and unit costs (see below))
H2 - cost per unit of cultivated area of energy inputs used in transportation ($/ha) (calculated from C, G2 and unit costs)
H3 - cost per unit of cultivated area of energy inputs used for "other uses" ($/ha) (calculated from C, G3 and unit costs)
H4 - total cost per unit of cultivated area of energy inputs in production, transportation and "other uses" ($/ha) (sum of H1, H2 and H3) (see Figure 5.34)
H5 - summary of totals shown in tables H1, H2 and H3
H6 - same as table H1, but with liquid fuels and heating fuels combined in two groups (see Figure 5.35)

I1 - cost per unit of target output of energy inputs used in production ($/k$) (calculated from D, G1 and unit costs (see below))
I2 - cost per unit of target output of energy inputs used in transportation ($/k$) (calculated from D, G2 and unit costs)
I3 - cost per unit of target output of energy inputs used for "other uses" ($/k$) (calculated from D, G3 and unit costs) (totals of Tables I1, I2 and I3 are displayed graphically in Figure 5.36)
I4 - total cost per unit of target output of energy inputs in production, transportation and "other uses" ($/k$) (sum of I1, I2 and I3)

J1 - cost per unit of target output of all energy inputs used in production as percentage of the cost of all farm energy inputs (%) (calculated from I1 and I4)
J2 - cost per unit of target output of all energy inputs used in transportation as percentage of the cost of all farm energy inputs (%) (calculated from I2 and I4)
J3 - cost per unit of target output of all energy inputs used for "other uses" as percentage of the cost of all farm energy inputs (%) (calculated from I3 and I4)
J4 - same as table I1, but with liquid fuels and heating fuels combined in two groups (see Figure 5.37)

K - target output per unit of cultivated area ($/ha) (calculated from C and D)

L1 - energy inputs used in production per unit of cultivated area (physical units/ha) (calculated from C and G1)
L2 - energy inputs used in transportation per unit of cultivated area (physical units/ha) (calculated from C and G2)
L3 - energy inputs used for "other uses" per unit of cultivated area (physical units/ha) (calculated from C and G3)
L4 - total energy inputs per unit of cultivated area (physical units/ha) (sum of M1, M2 and M3)
M - liquid fuel (diesel fuel and gasoline, expressed as liters of diesel fuel equivalent (dfe)) used in production and transportation per unit of cultivated area (L(dfe)/ha)

The column to the right of farm 23 (headed 1-23) shows results for the aggregate of the 22 farms.

Target Outputs

In an attempt to find a common denominator for comparing the energy intensity of all farms in the program and to avoid the problem of farm output variations due to climate, we designed a measure which we called the "target output" for each farm. This was arrived at as follows:

We took the areas in crop on summerfallow, crop on stubble and in perennial crops. We multiplied these areas by the yields of wheat, wheat and hay, respectively, which the farmer could expect to obtain in his area using normal farm practices and under normal climatic conditions.

We took the number of livestock of each kind the farmer could expect to sell in an average year, considering the current size of his livestock operation.

We took the quantity of milk the farmer could expect to sell in an average year considering the size of his dairy herd.

We multiplied these estimated total production units of wheat, hay, animals and milk by their respective current market values per unit to arrive at the total dollar value of each product. We gave the name "target output" to the sum of these dollar values.

Our assumption was that energy inputs remain relatively constant, barring a significant change in farm size or operations, while farm production may show major fluctuations from year to year.

Table 5.24-1

Table 5.24 - Summary of energy inputs, 1983 - page 1 of 7

	farm no.		1	2	3	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	1-23
																									+01/bbl
A1	energy inputs	L D	25139	28300	19939	11398	24618	22840	34568	3744	11975	3784	6105	19016	15908	46821	13461	5438	27847	2178	14806	17391	11897	2591	0.36
	units/a	L G	8795	24087	13351	13369	21959	33380	38982	6170	19875	4444	8050	20641	13047	25006	8295	7669	27680	8408	11369	18432	7439	3675	0.39
	1983	L HO	5079	7055	0	0	3515	3628	18773	4600	0	0	2534	0	0	0	2306	919	0	1579	0	0	0	0	0.334
		L P	1948	0	0	0	0	0	0	0	0	0	54	6050	0	9939	0	0	0	403	0	8258	0	0	0.27
		m3 NG	0	0	3798	0	0	0	0	0	0	0	0	0	0	0	0	0	7963	0	2195	0	0	0	0.13
		kg W	1100	0	0	0	6700	11000	2800	0	0	20000	0	0	0	0	0	0	0	0	0	0	0	0	0.00001
		kW.h E	34127	39838	27370	41380	37660	97951	18000	13440	182080	4962	24303	239220	37460	67167	27736	28840	33890	10055	12772	154728	171120	0	0.038
		kg N	27272	15071	16178	10641	35071	2865	64929	1062	0	549	0	16573	11035	40545	1388	6079	9131	0	3876	7079	61217	1643	0.63
		kg P2O5	13938	7000	9724	8115	12270	4310	38897	2583	0	2545	0	8448	12536	29098	6942	4790	13416	0	11104	8915	9979	2105	0.63
		kgAI HB	476	258	331	352	949	352	709	4	0	0	35	385	461	974	337	149	1369	0	853	217	388	35	HB
A2	herbicide cost	$/kg	21	15	16	17	23	18	25	48	0	0	19	19	18	22	25	45	21	0	25	15	66	33	23.67
B	energy values	D	38.7	38.7	38.7	39.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	
	MJ/unit	G	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	
	1983	HO	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	
		P	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	
		NG	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	
		W	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	
		E	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	
		N	61.0	60.0	61.0	75.0	64.0	76.0	74.0	77.0	0.0	83.0	0.0	74.0	65.0	62.0	83.0	75.0	67.0	0.0	79.0	69.0	73.0	74.0	
		P2O5	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	0.0	11.0	0.0	11.0	11.0	11.0	11.0	11.0	11.0	0.0	11.0	11.0	11.0	11.0	
		HB	247.9	178.3	256.0	210.8	267.7	210.2	297.6	320.0	0.0	0.0	142.9	215.6	198.9	310.1	249.3	335.7	247.6	0.0	260.3	248.8	335.7	257.1	
C	cultivated area	cult ha	571	713	504	501	696	686	1219	312	176	266	180	535	820	1730	628	345	1246	121	968	603	518	110	13448
D	target production 1983	kt	426	194	138	160	275	228	462	57	233	61	55	260	195	419	122	89	275	56	201	346	236	22	4510

D	= diesel fuel	W	= wood
G	= gasoline	E	= electricity
HO	= heating oil	N	= nitrogen
P	= propane	P2O5	= phosphate
NG	= natural gas	HB	= herbicides

Table 5.24-2

Table 5.24 - Summary of energy inputs, 1983 - page 2 of 7

	farm no.		1	2	3	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	1-23
E1	energy inputs	D	974	1095	772	441	953	884	1338	145	463	143	234	736	616	1812	521	210	1078	84	373	673	449	100	14296
	GJ/a	G	303	859	461	461	758	1152	1345	213	686	153	278	712	450	863	786	265	955	290	392	636	257	127	11900
	1983	HO	197	273	0	0	136	140	727	178	0	0	98	0	0	0	89	36	0	61	0	0	0	0	1935
		P	50	0	0	0	0	0	0	0	0	0	1	155	0	254	0	0	0	10	0	211	0	0	682
		NG	0	0	216	0	0	0	0	0	0	0	0	0	0	0	0	0	296	0	82	0	0	0	594
		W	17	0	0	0	104	171	43	0	0	310	0	0	0	0	0	0	0	0	0	0	0	0	645
		E	123	143	99	149	136	353	65	48	655	18	87	861	133	242	100	104	122	36	46	557	616	0	4695
		N	1664	904	987	798	2245	218	4805	82	0	46	0	1226	717	2514	115	456	612	0	306	488	4469	122	22773
		P205	153	77	107	89	135	47	428	28	0	28	0	93	138	320	76	53	170	0	122	98	110	24	2296
		HB	118	46	85	77	254	74	211	1	0	0	5	83	88	302	84	53	339	0	222	54	138	9	2243
		total	3598	3398	2725	2016	4719	3038	8961	696	1805	698	706	3866	2144	6307	1272	1176	3571	482	1743	2718	6038	381	62058
E2	energy inputs	D	27.1	32.2	28.3	21.9	20.2	29.1	14.9	20.8	25.7	20.5	33.5	19.0	28.7	28.7	41.0	17.9	30.2	17.5	32.9	24.8	7.4	26.3	23.0
	GJ/a	G	8.4	25.3	16.9	22.9	16.1	37.9	15.0	30.6	38.0	22.0	39.3	18.4	21.0	13.7	22.5	22.5	26.7	60.2	22.5	23.4	4.3	33.3	19.2
	1983	HO	5.5	8.0	0.0	0.0	2.9	4.6	8.1	25.6	0.0	0.0	13.9	0.0	0.0	0.0	7.0	3.0	0.0	12.7	0.0	0.0	0.0	0.0	3.1
	% of total	P	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	4.0	0.0	4.0	0.0	0.0	0.0	2.1	0.0	7.8	0.0	0.0	1.1
		NG	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	4.7	0.0	0.0	0.0	1.0
		W	0.5	0.0	0.0	0.0	2.2	5.6	0.5	0.0	0.0	44.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
		E	3.4	4.2	3.6	7.4	2.9	11.6	0.7	7.0	36.3	2.6	12.4	22.3	6.3	3.8	7.9	8.8	3.4	7.5	2.6	20.5	10.2	0.0	7.6
		N	46.2	26.6	36.2	39.6	47.6	7.2	53.6	11.8	0.0	6.5	0.0	31.7	33.5	39.9	9.1	38.8	17.1	0.0	17.6	18.0	74.0	31.9	36.7
		P205	4.3	2.3	3.9	4.4	2.9	1.6	4.8	4.1	0.0	4.0	0.0	2.4	6.4	5.1	6.0	4.5	4.7	0.0	7.0	3.6	1.8	6.2	3.7
		HB	3.3	1.4	3.1	3.8	5.4	2.4	2.4	0.2	0.0	0.0	0.7	2.1	4.1	4.8	6.6	4.5	9.5	0.0	12.7	2.0	2.3	2.4	3.6
E3	energy inputs	D	1.71	1.54	1.53	0.88	1.37	1.29	1.10	0.46	2.63	0.54	1.31	1.38	0.75	1.05	0.83	0.61	0.86	0.70	0.39	1.12	0.87	0.91	1.06
	GJ/ha	G	0.53	1.20	0.91	0.92	1.09	1.68	1.10	0.68	3.90	0.58	1.54	1.33	0.55	0.50	0.46	0.77	0.77	2.40	0.41	1.05	0.50	1.15	0.88
	1983	HO	0.34	0.38	0.00	0.00	0.20	0.20	0.60	0.57	0.00	0.00	0.54	0.00	0.00	0.00	0.14	0.10	0.00	0.51	0.00	0.00	0.00	0.00	0.14
		P	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.29	0.00	0.15	0.00	0.00	0.00	0.09	0.00	0.35	0.00	0.00	0.05
		NG	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.08	0.00	0.00	0.00	0.04
		W	0.03	0.00	0.00	0.00	0.15	0.25	0.04	0.00	0.00	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
		E	0.22	0.20	0.20	0.30	0.19	0.51	0.05	0.16	3.72	0.07	0.49	1.61	0.16	0.14	0.16	0.30	0.10	0.30	0.05	0.92	1.19	0.00	0.35
		N	2.91	1.27	1.96	1.59	3.22	0.32	3.94	0.26	0.00	0.17	0.00	2.29	0.87	1.45	0.18	1.32	0.49	0.00	0.32	0.81	8.63	1.11	1.69
		P205	0.27	0.11	0.21	0.18	0.19	0.07	0.35	0.09	0.00	0.11	0.00	0.17	0.17	0.19	0.12	0.15	0.14	0.00	0.13	0.16	0.21	0.21	0.17
		HB	0.21	0.06	0.17	0.15	0.37	0.11	0.17	.00	0.00	0.00	0.03	0.16	0.11	0.17	0.13	0.15	0.27	0.00	0.23	0.09	0.27	0.08	0.17
		total	6.30	4.77	5.41	4.02	6.78	4.43	7.35	2.23	10.25	2.62	3.92	7.23	2.61	3.65	2.03	3.41	2.87	3.98	1.80	4.51	11.66	3.47	4.61
E4	energy inputs	LF	35.5	57.5	45.2	44.8	36.2	67.0	29.9	51.4	63.7	42.5	72.8	37.5	49.7	42.4	63.5	40.4	56.9	77.7	55.4	48.2	11.7	59.6	
	GJ/a	HF	7.3	8.0	7.9	0.0	5.1	10.2	8.6	25.6	0.0	44.4	14.1	4.0	0.0	4.0	7.0	3.0	8.3	14.8	4.7	7.8	0.0	0.0	
	1983	E	3.4	4.2	3.6	7.4	2.9	11.6	0.7	7.0	36.3	2.6	12.4	22.3	6.3	3.8	7.9	8.8	3.4	7.5	2.6	20.5	10.2	0.0	
	% of total	N	46.2	26.6	36.2	39.6	47.6	7.2	53.6	11.8	0.0	6.5	0.0	31.7	33.5	39.9	9.1	38.8	17.1	0.0	17.6	18.0	74.0	31.9	
		P205	4.3	2.3	3.9	4.4	2.9	1.6	4.8	4.1	0.0	4.0	0.0	2.4	6.4	5.1	6.0	4.5	4.7	0.0	7.0	3.6	1.8	6.2	
		HB	3.3	1.4	3.1	3.8	5.4	2.4	2.4	0.2	0.0	0.0	0.7	2.1	4.1	4.8	6.6	4.5	9.5	0.0	12.7	2.0	2.3	2.4	
E5	energy inputs	LF	2.2	2.7	2.4	1.8	2.5	3.0	2.2	1.1	6.5	1.1	2.9	2.7	1.3	1.5	1.3	1.4	1.6	3.1	1.0	2.2	1.4	2.1	
	GJ/ha	HF	0.5	0.4	0.4	0.0	0.3	0.5	0.6	0.6	0.0	1.2	0.6	0.3	0.0	0.1	0.1	0.1	0.2	0.6	0.1	0.4	0.0	0.0	
	1983	E	0.2	0.2	0.2	0.3	0.2	0.5	0.1	0.2	3.7	0.1	0.5	1.6	0.2	0.1	0.2	0.3	0.1	0.3	.0	0.9	1.2	0.0	
		N	2.9	1.3	2.0	1.6	3.2	0.3	3.9	0.3	0.0	0.2	0.0	2.3	0.9	1.5	0.2	1.3	0.5	0.0	0.3	0.8	8.6	1.1	
		P205	0.3	0.1	0.2	0.2	0.2	0.1	0.4	0.1	0.0	0.1	0.0	0.2	0.2	0.2	0.1	0.2	0.1	0.0	0.1	0.2	0.2	0.2	
		HB	0.2	0.1	0.2	0.2	0.4	0.1	0.2	.0	0.0	0.0	.0	0.2	0.1	0.2	0.1	0.2	0.3	0.0	0.2	0.1	0.3	0.1	

LF = LIQUID FUELS (DIESEL FUEL + GASOLINE)
HF = HEATING FUELS (HEATING OIL + PROPANE + NATURAL GAS + WOOD)

Table 5.24-3

Table 5.24 - Summary of energy inputs, 1983 - page 3 of 7

	farm no.		1	2	3	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	1-23
F1	production	D	0.87	0.97	0.99	0.96	0.99	0.91	0.96	0.98	1.00	0.78	0.93	0.81	1.00	0.98	0.96	1.00	0.99	0.97	1.00	1.00	0.64	0.92	
	fraction	G	0.52	0.30	0.11	0.24	0.34	0.12	0.30	0.25	0.27	0.43	0.14	0.28	0.21	0.02	0.46	0.47	0.30	0.33	0.44	0.37	0.51	0.26	
	1983	HO	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		P	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.48	0.00	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		NG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		E	0.37	0.00	0.18	0.00	0.00	0.58	0.00	0.00	0.83	0.00	0.21	0.85	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	
		N	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
		P205	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
		HB	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
F2	transportation	D	0.10	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.19	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	
	fraction	G	0.46	0.69	0.85	0.70	0.63	0.81	0.63	0.70	0.36	0.55	0.79	0.66	0.78	0.95	0.49	0.50	0.70	0.65	0.55	0.45	0.38	0.74	
	1983	HO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		NG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		P205	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		HB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
F3	other uses	D	0.03	0.03	0.01	0.04	0.01	0.09	0.01	0.02	0.00	0.03	0.07	0.01	0.00	0.02	0.04	0.00	0.01	0.03	0.00	0.00	0.01	0.08	
	fraction	G	0.02	0.01	0.04	0.06	0.03	0.07	0.07	0.05	0.37	0.02	0.07	0.06	0.01	0.03	0.05	0.03	0.00	0.02	0.01	0.18	0.11	0.00	
	1983	HO	0.53	1.00	0.00	0.00	1.00	1.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00	0.00	1.00	
		P	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.52	0.00	0.38	0.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	
		NG	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	
		W	1.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		E	0.63	1.00	0.82	1.00	1.00	0.42	1.00	1.00	0.17	1.00	0.79	0.15	1.00	0.87	1.00	1.00	1.00	1.00	1.00	0.21	1.00	1.00	
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		P205	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		HB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table 5.24-4

Table 5.24 - Summary of energy inputs, 1983 - page 4 of 7

farm no.		1	2	3	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	1-23
G1 energy inputs to	L D	21000	27451	19740	10942	24372	20784	33185	3669	11975	2889	5670	15403	15900	45885	12923	5438	27569	2113	14806	17391	7422	2384	349814
production	L G	4573	7466	1469	3209	7466	4006	11695	1543	5366	1911	1127	5779	2740	500	3816	3604	8304	2775	5002	6820	3794	956	93919
units/a	L HO	2387	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2387
1983	L P	0	0	0	0	0	0	0	0	0	0	0	2904	0	6162	0	0	0	0	0	0	0	0	9066
	m3 NG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kW.h E	12627	0	4927	0	0	56812	0	0	151126	0	3104	203337	0	8732	0	0	0	0	0	122235	0	0	564899
	kg N	27272	15071	16178	10641	35071	2865	64929	1062	0	349	0	16573	11035	40545	1388	6079	9131	0	3876	7079	61217	1643	332204
	kg P205	13938	7000	9724	8115	12270	4310	38897	2583	0	2545	0	8448	12536	29098	6942	4790	15416	0	11104	8915	9979	2145	208755
	kgAI HB	476	258	331	352	949	352	709	4	0	0	35	385	461	974	337	149	1369	0	853	217	388	35	8634
G2 energy inputs to	L D	2516	0	0	0	0	0	1037	0	0	704	0	3423	0	0	0	0	0	0	0	0	4059	0	11739
transportation	L G	4046	17172	11348	9358	13834	27038	24559	4319	7155	2444	6360	13623	10177	23756	4065	3835	19376	5465	6253	8294	2827	2720	220022
units/a	L HO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	L P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	m3 NG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kW.h E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg P205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kgAI HB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G3 energy inputs to	L D	755	849	199	456	246	2056	346	75	0	111	427	190	0	934	538	0	278	65	0	0	116	207	7852
other uses	L G	176	249	534	802	659	2337	2729	309	7354	89	564	1238	130	750	415	230	0	168	114	3318	818	0	22982
units/a	L HO	2692	7055	0	0	3515	3628	18773	4600	0	0	2534	0	0	0	2306	919	0	1579	0	0	0	0	47601
	L P	1948	0	0	0	0	0	0	0	0	0	54	3146	0	3777	0	0	0	803	0	8258	0	0	17986
	m3 NG	0	0	5798	0	0	0	0	0	0	0	0	0	0	0	0	0	7963	0	2195	0	0	0	15956
	kg W	1100	0	0	0	6700	11000	2800	0	0	20000	0	0	0	0	0	0	0	0	0	0	0	0	41600
	kW.h E	21500	39836	22443	41300	37660	41139	18000	13440	30954	4962	19199	35883	37460	58435	27736	28840	33890	10055	12772	32493	171120	0	739200
	kg N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg P205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kgAI HB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G4 energy inputs	LF	1.8	1.9	1.6	1.1	1.7	1.4	1.4	0.6	3.7	0.7	1.4	1.5	0.9	1.0	1.0	1.0	1.1	1.5	0.8	1.5	0.8	1.1	
to production	HF	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GJ/ha	E	0.1	0.0	.0	0.0	0.0	0.3	0.0	0.0	3.1	0.0	0.1	1.4	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	
	N	2.9	1.3	2.0	1.6	3.2	0.3	3.9	0.3	0.0	0.2	0.0	2.3	0.9	1.5	0.2	1.3	0.5	0.0	0.3	0.8	0.6	1.1	
	P205	0.3	0.1	0.2	0.2	0.2	0.1	0.4	0.1	0.0	0.1	0.0	0.2	0.2	0.2	0.1	0.2	0.1	0.0	0.1	0.2	0.2	0.2	
	HB	0.2	0.1	0.2	0.2	0.4	0.1	0.2	.0	0.0	0.0	.0	0.2	0.1	0.2	0.1	0.2	0.3	0.0	0.2	0.1	0.3	0.1	
G5 energy inputs	LF	0.4	0.8	0.8	0.6	0.7	1.4	0.7	0.5	1.4	0.4	1.2	1.1	0.4	0.5	0.2	0.4	0.5	1.6	0.2	0.5	0.5	0.9	
to transportation	HF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GJ/ha	E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	P205	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	HB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
G6 energy inputs	LF	0.1	0.1	0.1	0.1	.0	0.2	0.1	.0	1.4	.0	0.2	0.1	.0	.0	0.1	.0	.0	0.1	.0	0.2	0.1	0.1	
to other uses	HF	0.3	0.4	0.4	0.0	0.3	0.5	0.6	0.6	0.0	1.2	0.6	0.2	0.0	0.1	0.1	0.1	0.2	0.6	0.1	0.4	0.0	0.0	
GJ/ha	E	0.1	0.2	0.2	0.3	0.2	0.2	0.1	0.2	0.6	0.1	0.4	0.2	0.2	0.1	0.2	0.3	0.1	0.3	.0	0.2	1.2	0.0	
	N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	P205	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	HB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table 5.24-5

Table 5.24 - Summary of energy inputs, 1983 - page 5 of 7

	farm no.			1	2	3	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	1-23
M1	cost of energy inputs to production $/ha 1983	D		13.00	13.06	14.10	7.86	12.61	10.91	9.80	4.23	24.49	3.91	11.36	10.36	6.98	9.55	7.41	5.67	7.97	6.29	5.51	10.38	5.16	7.80	9.36
		G		3.12	4.00	1.14	2.50	4.18	2.28	3.74	1.93	11.09	2.80	2.44	4.21	1.30	0.11	2.37	4.07	2.60	8.94	2.02	4.41	2.86	3.39	2.72
		HO		1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
		P		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.18
		NG		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		W		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		E		0.84	0.00	0.37	0.00	0.00	3.15	0.00	0.00	32.63	0.00	1.08	14.44	0.00	0.19	0.00	0.00	0.00	0.00	0.00	7.70	0.00	0.00	1.60
		N		30.09	13.32	20.22	13.38	31.75	2.63	33.56	2.14	0.00	1.30	0.00	19.52	8.48	14.76	1.39	11.10	4.62	0.00	2.52	7.40	74.45	9.41	15.56
		P2O5		15.38	6.19	12.16	10.20	11.11	3.96	20.10	5.22	0.00	6.03	0.00	9.95	9.63	10.60	6.96	8.75	7.79	0.00	7.23	9.31	12.14	12.29	9.78
		KO		17.51	5.43	10.51	11.94	31.36	9.24	14.54	0.62	0.00	0.00	3.69	13.67	10.12	12.39	13.42	19.43	23.07	0.00	22.03	5.40	49.44	10.50	13.48
			sum	82.13	42.87	58.49	45.89	91.00	32.16	81.74	14.14	69.02	14.04	18.57	73.62	36.52	48.56	31.55	49.03	46.05	15.23	39.30	44.60	144.04	43.38	52.75
M2	cost of energy inputs to transportation $/ha	D		1.59	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.95	0.00	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.82	0.00	0.31
		G		2.76	9.39	8.78	7.28	7.75	15.37	7.86	5.40	15.85	3.58	13.78	9.93	4.84	5.36	2.52	4.33	6.06	17.62	2.52	5.36	2.13	9.64	6.61
		HO		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		P		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		NG		0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		W		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		E		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		P2O5		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		KO		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			sum	4.35	9.39	8.78	7.28	7.75	15.37	8.16	5.40	15.85	4.54	13.78	12.23	4.84	5.36	2.52	4.33	6.06	17.62	2.52	5.36	4.95	9.64	6.93
M3	cost of energy inputs to other uses $/ha	D		0.48	0.43	0.14	0.33	0.13	1.00	0.10	0.09	0.00	0.15	0.85	0.13	0.00	0.19	0.31	0.00	0.08	0.19	0.00	0.00	0.08	0.68	0.21
		G		0.12	0.14	0.41	0.62	0.37	1.33	0.87	0.39	16.30	0.13	1.22	0.90	0.06	0.17	0.26	0.26	0.00	0.54	0.05	2.15	0.62	0.00	0.67
		HO		1.57	3.30	0.00	0.00	1.69	1.77	5.14	4.92	0.00	0.00	4.70	0.00	0.00	0.00	1.23	0.89	0.00	4.36	0.00	0.00	0.00	0.00	1.18
		P		0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	1.59	0.00	0.59	0.00	0.00	0.00	0.90	0.00	3.70	0.00	0.00	0.35
		NG		0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.00	0.29	0.00	0.00	0.00	0.15
		W		.00	0.00	0.00	0.00	.00	.00	.00	0.00	0.00	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
		E		1.43	2.12	1.69	3.14	2.06	2.28	0.56	1.64	6.68	0.71	4.05	2.55	1.74	1.28	1.68	3.18	1.03	3.16	0.50	2.05	12.55	0.00	2.09
		N		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		P2O5		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		KO		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			sum	4.52	5.99	3.74	4.09	4.24	6.45	6.68	7.03	22.98	0.99	10.91	5.17	1.80	2.24	3.47	4.33	1.94	9.15	0.84	7.89	13.25	0.68	4.66
M4	total cost of energy inputs to farm $/ha	D		15.86	14.29	14.24	8.19	12.73	11.99	10.21	4.32	24.49	5.01	12.21	12.80	6.98	9.74	7.72	5.67	8.05	6.48	5.51	10.38	8.06	8.48	9.89
		G		6.01	13.61	10.33	10.41	12.30	18.98	12.47	7.71	44.04	6.52	17.44	15.05	6.21	5.64	5.15	8.67	8.66	27.10	4.58	11.92	5.60	13.03	10.00
		HO		2.97	3.30	0.00	0.00	1.69	1.77	5.14	4.92	0.00	0.00	4.70	0.00	0.00	0.00	1.23	0.89	0.00	4.36	0.00	0.00	0.00	0.00	1.24
		P		0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	3.05	0.00	1.55	0.00	0.00	0.00	0.90	0.00	3.70	0.00	0.00	0.54
		NG		0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.00	0.29	0.00	0.00	0.00	0.15
		W		.00	0.00	0.00	0.00	.00	.00	.00	0.00	0.00	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
		E		2.27	2.12	2.06	3.14	2.06	5.43	0.56	1.64	39.31	0.71	5.13	16.99	1.74	1.48	1.68	3.18	1.03	3.16	0.50	9.75	12.55	0.00	3.68
		N		30.09	13.32	20.22	13.38	31.75	2.63	33.56	2.14	0.00	1.30	0.00	19.52	8.48	14.76	1.39	11.10	4.62	0.00	2.52	7.40	74.45	9.41	15.56
		P2O5		15.38	6.19	12.16	10.20	11.11	3.96	20.10	5.22	0.00	6.03	0.00	9.95	9.63	10.60	6.96	8.75	7.79	0.00	7.23	9.31	12.14	12.29	9.78
		KO		17.51	5.43	10.51	11.94	31.36	9.24	14.54	0.62	0.00	0.00	3.69	13.67	10.12	12.39	13.42	19.43	23.07	0.00	22.03	5.40	49.44	10.50	13.48
			sum	91.01	58.26	71.02	57.27	102.99	53.98	96.58	26.57	107.85	19.57	43.26	91.02	43.15	56.15	37.54	57.69	54.06	42.00	42.66	57.86	162.24	53.70	64.33
M5	production		$/ha	82.13	42.87	58.49	45.89	91.00	32.16	81.74	14.14	69.02	14.04	18.57	73.62	36.52	48.56	31.55	49.03	46.05	15.23	39.30	44.60	144.04	43.38	
	transportation		$/ha	4.35	9.39	8.78	7.28	7.75	15.37	8.16	5.40	15.85	4.54	13.78	12.23	4.84	5.36	2.52	4.33	6.06	17.62	2.52	5.36	4.95	9.64	
	other uses		$/ha	4.52	5.99	3.74	4.09	4.24	6.45	6.68	7.03	22.98	0.99	10.91	5.17	1.80	2.24	3.47	4.33	1.94	9.15	0.84	7.89	13.25	0.68	
M6	cost of energy inputs to production $/ha	LF		16.92	17.94	15.24	10.36	16.79	13.18	13.54	6.16	36.39	6.71	13.80	14.58	8.29	9.66	9.78	9.75	10.56	15.23	7.52	14.79	8.01	11.19	
		NF		1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		E		0.84	0.00	0.37	0.00	0.00	3.15	0.00	0.00	32.63	0.00	1.08	14.44	0.00	0.19	0.00	0.00	0.00	0.00	0.00	7.70	0.00	0.00	
		N		30.09	13.32	20.22	13.38	31.75	2.63	33.56	2.14	0.00	1.30	0.00	19.52	8.48	14.76	1.39	11.10	4.62	0.00	2.52	7.40	74.45	9.41	
		P2O5		15.38	6.19	12.16	10.20	11.11	3.96	20.10	5.22	0.00	6.03	0.00	9.95	9.63	10.60	6.96	8.75	7.79	0.00	7.23	9.31	12.14	12.29	
		KO		17.51	5.43	10.51	11.94	31.36	9.24	14.54	0.62	0.00	0.00	3.69	13.67	10.12	12.39	13.42	19.43	23.07	0.00	22.03	5.40	49.44	10.50	

Table 5.24-6

Table 5.24 - Summary of energy inputs, 1983 - page 6 of 7

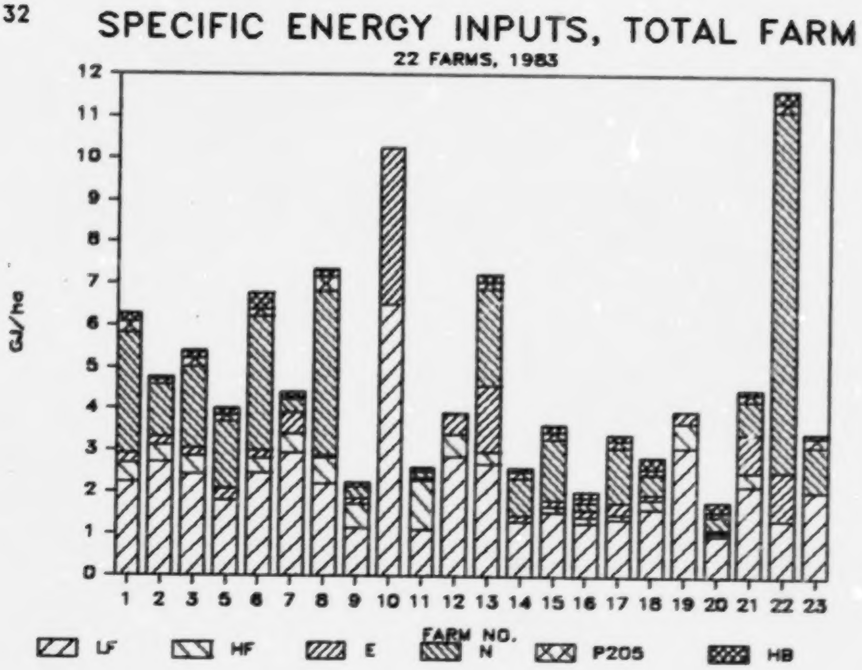
	farm no.		1	2	3	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	1-23
I1	cost of energy inputs to production per $1000 target output $/kt	D	18.50	50.94	51.49	24.62	31.90	32.82	25.86	23.17	18.50	17.05	37.16	21.33	29.37	39.42	38.13	22.00	36.09	13.58	26.52	18.09	11.32	39.01	27.92
		G	4.19	15.01	4.15	7.82	10.59	6.85	9.87	10.55	8.98	12.22	7.99	8.67	5.48	0.47	12.20	15.79	11.78	19.32	9.71	7.69	6.27	16.94	8.12
		HO	1.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
		P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.02	0.00	3.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34
		NG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		E	1.13	0.00	1.36	0.00	0.00	9.47	0.00	0.00	24.65	0.00	3.53	29.72	0.00	0.79	0.00	0.00	0.00	0.00	0.00	13.42	0.00	0.00	4.76
		N	40.33	48.94	73.86	41.90	80.34	7.92	88.54	11.74	0.00	5.67	0.00	40.16	35.65	60.96	7.17	43.03	20.92	0.00	12.15	12.89	163.42	47.05	46.41
		P2O5	20.61	22.73	44.39	31.95	28.11	11.91	53.04	28.55	0.00	26.28	0.00	20.47	40.50	43.75	35.85	33.91	35.32	0.00	34.80	16.23	26.64	61.43	29.16
		HB	23.46	19.95	38.38	37.40	79.37	27.79	38.37	3.37	0.00	0.00	12.09	28.13	42.55	51.14	69.06	75.34	104.54	0.00	106.09	9.41	108.51	52.50	45.31
		sum	110.09	157.57	213.63	143.69	230.32	96.75	215.68	77.38	52.13	61.22	60.77	151.49	153.55	200.51	162.40	190.07	208.64	32.90	189.27	77.74	316.16	216.92	162.40
I2	cost of energy inputs to transportation per $1000 target output $/kt	D	2.13	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	4.15	0.00	4.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.19	0.00	0.94
		G	3.70	34.52	32.07	22.81	19.62	46.25	20.73	29.55	11.98	15.63	45.09	20.43	20.35	22.11	12.99	16.80	27.48	38.06	12.13	9.35	4.67	48.21	19.72
		HO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		NG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		HB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		sum	5.83	34.52	32.07	22.81	19.62	46.25	21.54	29.55	11.98	19.78	45.09	25.17	20.35	22.11	12.99	16.80	27.48	38.06	12.13	9.35	10.86	48.21	20.66
I3	cost of energy inputs to other uses per $1000 target output $/kt	D	0.64	1.58	0.52	1.03	0.32	3.25	0.27	0.47	0.00	0.66	2.80	0.26	0.00	0.80	1.59	0.00	0.36	0.42	0.00	0.00	0.18	3.39	0.63
		G	0.16	0.50	1.51	1.96	0.93	4.00	2.30	2.11	12.31	0.57	4.00	1.86	0.26	0.70	1.33	1.01	0.00	1.17	0.22	3.74	1.35	0.00	1.99
		HO	2.11	12.15	0.00	0.00	4.27	5.31	13.57	26.95	0.00	0.00	15.39	0.00	0.00	0.00	6.31	3.45	0.00	9.42	0.00	0.00	0.00	0.00	3.53
		P	1.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	3.27	0.00	2.43	0.00	0.00	0.00	1.94	0.00	6.44	0.00	0.00	1.05
		NG	0.00	0.00	5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.76	0.00	1.42	0.00	0.00	0.00	0.46
		W	.00	0.00	0.00	0.00	.00	.00	.00	0.00	0.00	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
		E	1.92	7.80	6.18	9.83	5.20	6.86	1.48	8.96	5.05	3.09	13.27	5.24	7.30	5.30	8.64	12.31	4.68	6.82	2.41	3.57	27.55	0.00	6.23
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		HB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		sum	6.06	22.03	13.67	12.81	10.73	19.41	17.63	38.50	17.36	4.32	35.71	10.63	7.56	9.24	17.87	16.77	8.81	19.77	4.05	13.75	29.08	3.39	13.88
I4	total cost of energy inputs to farm per $1000 output $/kt 1983	D	21.26	52.52	52.01	25.65	32.23	36.06	26.94	23.65	18.50	21.86	39.96	26.33	29.37	40.23	39.72	22.00	36.45	14.00	26.52	18.09	17.69	42.40	29.49
		G	8.05	50.03	37.73	32.59	31.14	57.10	32.91	42.22	33.27	28.41	57.08	30.96	26.09	23.28	26.52	33.61	39.26	58.56	22.06	20.78	12.29	65.15	29.83
		HO	3.98	12.15	0.00	0.00	4.27	5.31	13.57	26.95	0.00	0.00	15.39	0.00	0.00	0.00	6.31	3.45	0.00	9.42	0.00	0.00	0.00	0.00	3.70
		P	1.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	6.28	0.00	6.40	0.00	0.00	0.00	1.94	0.00	6.44	0.00	0.00	1.60
		NG	0.00	0.00	5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.76	0.00	1.42	0.00	0.00	0.00	0.46
		W	.00	0.00	0.00	0.00	.00	.00	.00	0.00	0.00	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
		E	3.04	7.80	7.54	9.83	5.20	16.33	1.48	8.96	29.70	3.09	16.79	34.96	7.30	6.09	8.64	12.31	4.68	6.82	2.41	16.99	27.55	0.00	10.99
		N	40.33	48.94	73.86	41.90	80.34	7.92	88.54	11.74	0.00	5.67	0.00	40.16	35.65	60.96	7.17	43.03	20.92	0.00	12.15	12.89	163.42	47.05	46.41
		P2O5	20.61	22.73	44.39	31.95	28.11	11.91	53.04	28.55	0.00	26.28	0.00	20.47	40.50	43.75	35.85	33.91	35.32	0.00	34.80	16.23	26.64	61.43	29.16
		HB	23.46	19.95	38.38	37.40	79.37	27.79	38.37	3.37	0.00	0.00	12.09	28.13	42.55	51.14	69.06	75.34	104.54	0.00	106.09	9.41	108.51	52.50	45.31
		sum	121.98	214.11	259.36	179.31	260.66	162.41	254.84	145.43	81.464	85.320	141.57	187.29	181.46	231.85	193.26	223.63	244.93	90.740	205.45	100.83	356.10	268.52	196.94
	J1 production (sum I1)	%	90	74	82	80	88	60	85	53	64	72	43	81	85	86	84	85	85	36	92	77	89	81	82
	J2 transportation (sum I2)	%	5	16	12	13	8	28	8	20	15	23	32	13	11	10	7	8	11	42	6	9	3	18	10
	J3 other uses (sum I3)	%	5	10	5	7	4	12	7	26	21	5	25	6	4	4	9	7	4	22	2	14	8	1	7
	total	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 5.24-7

Table 5.24 - Summary of energy inputs, 1983 - page 7 of 7

farm no.		1	2	3	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	1-23
J4 cost of energy	LF	22.68	65.95	55.65	32.44	42.49	39.67	35.73	33.73	27.48	29.27	45.15	30.00	34.85	39.89	50.33	37.79	47.87	32.90	36.22	25.78	17.59	53.94	
inputs to	HF	1.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.02	0.00	3.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
production	E	1.13	0.00	1.36	0.00	0.00	7.47	0.00	0.00	24.65	0.00	3.53	29.72	0.00	0.79	0.00	0.00	0.00	0.00	0.00	13.42	0.00	0.00	
per $1000	N	40.33	48.94	73.86	41.90	80.34	7.92	88.54	11.74	0.00	5.67	0.00	40.16	35.65	60.96	7.17	43.03	20.92	0.00	12.15	12.89	163.42	47.05	
target output	P2O5	20.61	22.73	44.39	31.95	28.11	11.91	53.04	28.55	0.00	26.28	0.00	20.47	40.50	43.75	35.35	33.91	35.32	0.00	34.80	16.23	26.64	61.43	
$/ha	HB	23.46	19.95	38.38	37.40	79.37	27.79	38.37	3.37	0.00	0.00	12.09	28.13	42.55	51.14	69.36	75.34	104.54	0.00	106.09	9.41	108.51	52.50	
K output	$/ha	746	272	274	319	395	332	379	183	1324	229	306	486	230	242	194	258	221	463	208	374	456	200	335
L1 energy inputs to	L D	38	39	39	22	35	30	27	12	68	11	32	29	19	27	21	16	22	17	15	29	14	22	26
production	L G	8	10	3	6	11	6	10	5	30	7	6	11	3	0	6	10	7	23	5	11	7	9	7
units/ha	L HO	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	L P	0	0	0	0	0	0	0	0	0	0	0	5	0	4	0	0	0	0	0	0	0	0	1
	m3 NG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kW.h E	22	0	10	0	0	83	0	0	859	0	28	300	0	5	0	0	0	0	0	203	0	0	42
	kg N	48	21	32	21	50	4	53	3	0	2	0	31	13	23	2	18	7	0	4	12	118	15	25
	kg P2O5	24	10	19	16	18	6	32	8	0	10	0	16	15	17	11	14	12	0	11	15	19	20	16
	kgAI HB	1	0	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0	1	0	1	0	1
L2 energy inputs to	L D	4	0	0	0	0	0	1	0	0	3	0	6	0	0	0	0	0	0	0	0	0	0	1
transportation	L G	7	24	23	19	20	39	20	14	41	9	35	25	12	14	6	11	16	45	6	14	5	25	17
units/ha	L HO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	L P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	m3 NG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kW.h E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg P2O5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kgAI HB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L3 energy inputs to	L D	1	1	0	1	0	3	0	0	0	0	2	0	0	1	1	0	0	1	0	0	0	2	1
other uses	L G	0	0	1	2	1	3	2	1	42	9	3	2	0	0	1	1	0	1	0	6	2	0	2
units/ha	L HO	5	10	0	0	5	5	15	15	0	0	14	0	0	0	4	3	0	13	0	0	0	0	4
	L P	3	0	0	0	0	0	0	0	0	0	0	6	0	2	0	0	0	3	0	14	0	0	1
	m3 NG	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	2	0	0	0	1
	kg W	2	0	0	0	10	16	2	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	3
	kW.h E	38	56	45	83	54	60	15	43	176	19	107	67	46	34	44	84	27	83	13	54	330	0	55
	kg N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg P2O5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kgAI HB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L4 energy inputs to	L D	44	40	40	23	35	33	28	12	68	14	34	36	19	27	21	16	22	18	15	29	22	24	27
total	L G	15	35	26	27	32	49	32	20	113	17	45	39	16	14	13	22	22	69	12	31	14	33	26
units/ha	L HO	9	10	0	0	5	5	15	15	0	0	14	0	0	0	4	3	0	13	0	0	0	0	4
	L P	3	0	0	0	0	0	0	0	0	0	0	11	0	6	0	0	0	3	0	14	0	0	2
	m3 NG	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	2	0	0	0	1
	kg W	2	0	0	0	10	16	2	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	3
	kW.h E	60	56	54	83	54	143	15	43	1035	19	135	447	46	39	44	84	27	83	13	257	330	0	97
	kg N	48	21	32	21	50	4	53	3	0	2	0	31	13	23	2	18	7	0	4	12	118	15	25
	kg P2O5	24	10	19	16	18	6	32	8	0	10	0	16	15	17	11	14	12	0	11	15	19	20	16
	kgAI HB	1	0	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0	1	0	1	0	1
R liquid fuel use		58	71	63	47	63	77	57	30	169	29	74	70	34	40	33	36	42	80	26	56	35	33	50

Figure 5.32



SPECIFIC ENERGY INPUTS, TOTAL FARM

22 FARMS, 1983

Figure 5.33

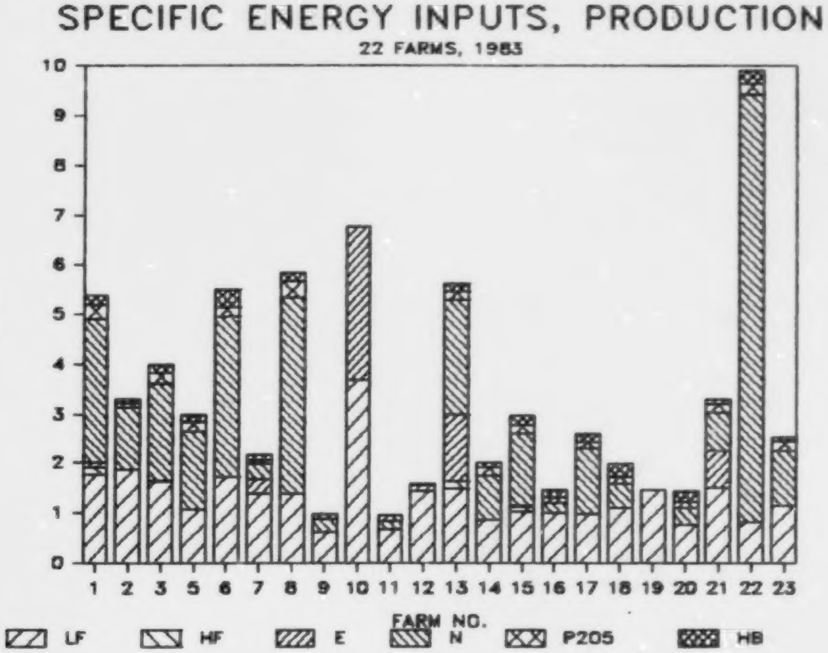

SPECIFIC ENERGY INPUTS, PRODUCTION
22 FARMS, 1983
GJ/ha
0
1
2
3
4
5
6
7
8
9
10
1
2
3
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
FARM NO.
LF
HF
E
N
P2O5
HB

Figure 5.34

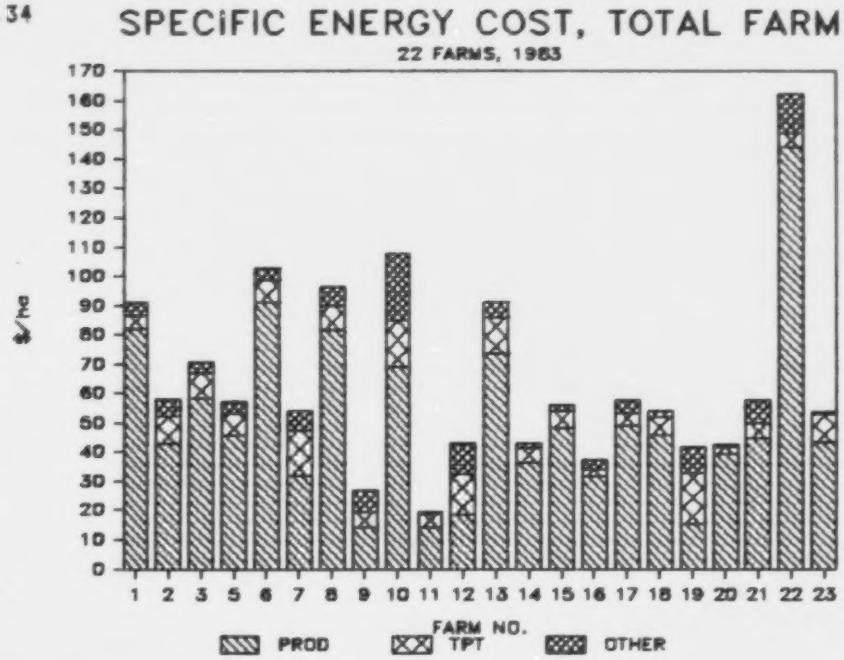

SPECIFIC ENERGY COST, TOTAL FARM
22 FARMS, 1983
$/ha
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1 2 3 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
FARM NO.
PROD
TPT
OTHER

Figure 5.35

SPECIFIC ENERGY COST, PRODUCTION

22 FARMS, 1983

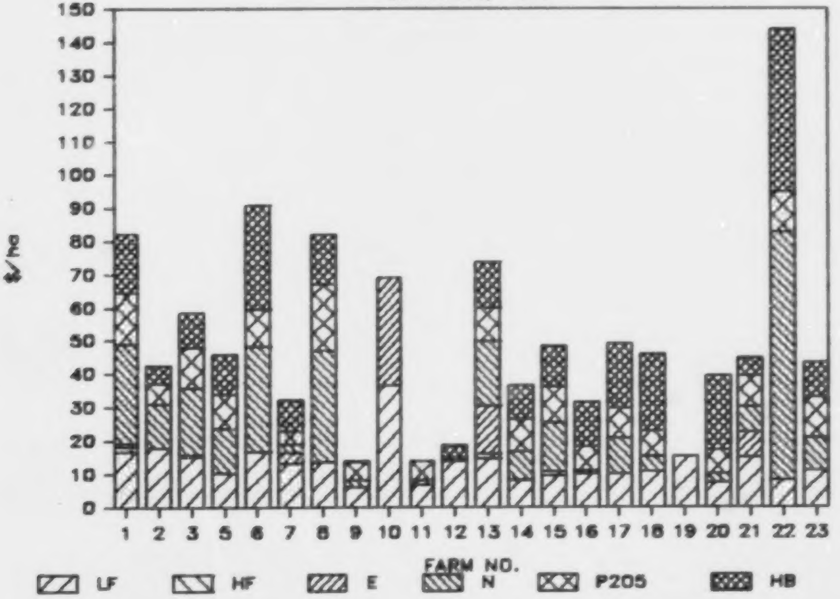


Figure 5.36 TOTAL ENERGY COST VS. TARGET OUTPUT

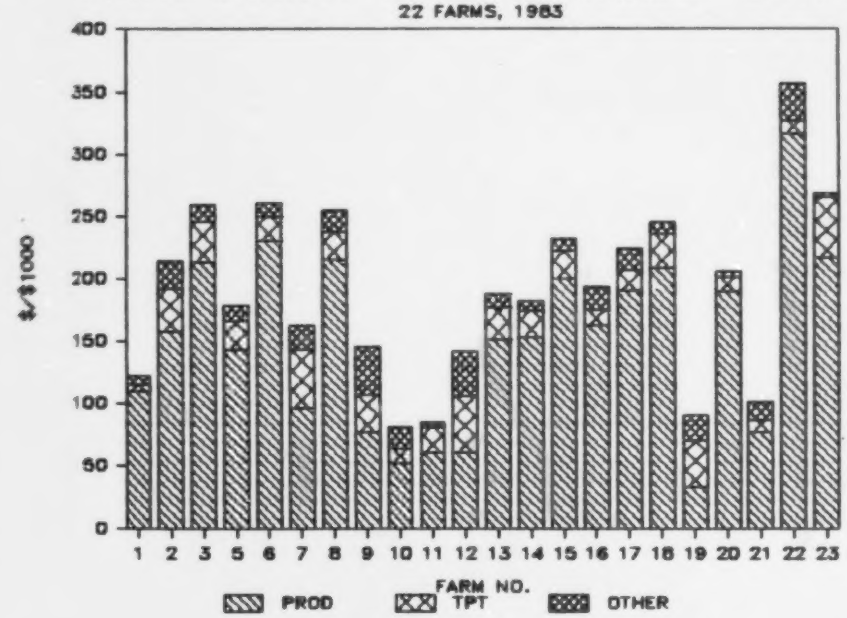
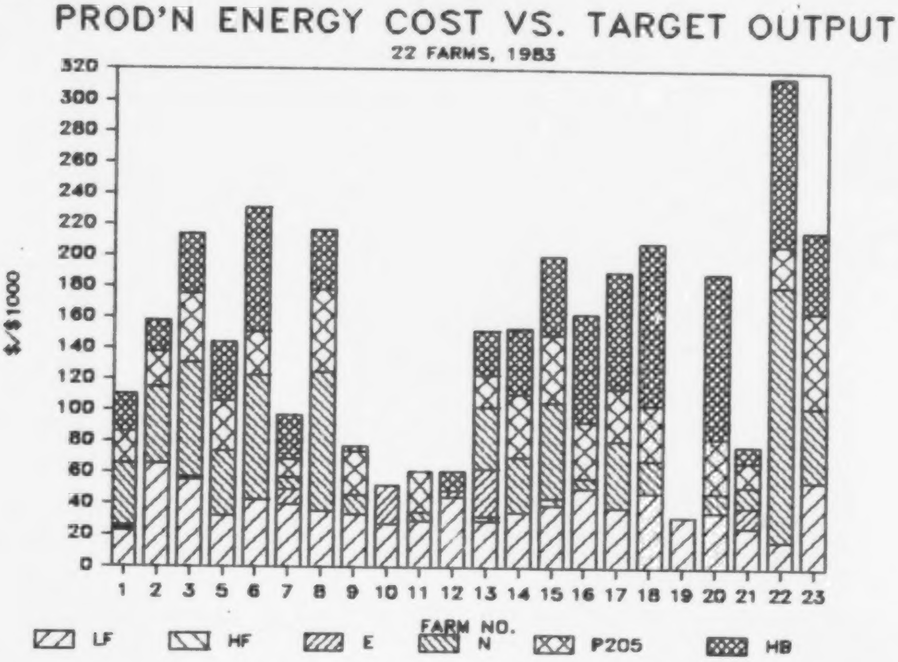


Figure 5.37


PROD'N ENERGY COST VS. TARGET OUTPUT
22 FARMS, 1983
$/$1000
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
1 2 3 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
FARM NO.
LF
HF
E
N
P205
HB

LIST OF APPENDICES

SAMPLE REPORTS - Farm No. 5

APPENDIX A

A-1 Legend
A-2 Fuel Log Detail Report

APPENDIX B

B-1 Liquid fuel Use by Equipment, 1983

APPENDIX C

C-1 Liquid Fuel Use by Operation, 1983

APPENDIX D

D-1 Use of Diesel Fuel by 10-day Period, 1983

APPENDIX E

E-1 Use of Gasoline by 10-day Period, 1983

APPENDIX F

F-1 Equipment Fuel Use by Month, 1983

CASE STUDIES

APPENDIX G

G-1 Farm 1
G-2 Farm 2
G-3 Farm 3
... .
... .
... .
G-23 Farm 23

APPENDIX A-1

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                              Farm Fuel Log Legend
Wed Jun 27 23:19:10 1984                                                                    Page 1

Farm      Eqpt_ID           Eqpt_Description                          Meter_Unit
     5    1070              Tractor, Case 1070, 1971                  h
     5    2390              Tractor, Case 2390, 1981                  h
     5    stod              Supplied to others                        h
     5    auger             Auger                                     h
     5    stog              Supplied to others                        h
     5    d600              Truck, 3 ton, Dodge 600, 1974             mi
     5    dart              Car, Dodge Dart, 1967                     mi
     5    gard t            Garden tractor                            h
     5    half t            Truck, 1/2 ton, Ford, 1974                mi
     5    ihc               Truck, 1.5 ton, IHC, 1952                 mi
     5    lawn m            Lawnmower                                 h
     5    non-eng           Non-energy use                            h
     5    olds              Car, Oldsmobile, 1979                     km
     5    oliver            Tractor, Oliver S-88, 1956                h
     5    swather           Swather, MF 34, 1964                      h
     5    pump              Pump                                      h
     5    non-end           Non-energy use                            h
     5    rt                Tractor, Case 1070, (rented)              h
     5    ford t            Tractor, Ford                             h
     5    mike              Car, Valiant, 1975                        mi
     5    nova              Car, Nova, 1976                           mi
Op_Type         Op_Description
s               Seeding
swc             Summerfallow & weed control
h               Harvest & hauling
li              Land improvement
fs              Farmstead
cm              Crop miscellaneous
t               Transportation
f               Feed
m               Manure
lm              Livestock miscellaneous
r               Recreation
s-c             Seeding, custom
swc-c           Summerfallow & weed control, custom
h-c             Harvest & hauling, custom
power           Power generation
o               Used by others
fo              Field operations
Fuel_Type      Fuel_Description
d              Diesel fuel
g              Gasoline
```

APPENDIX A-2

```
                                    Farm  Fuel  Log  Detail  Report
Wed Jun 27 23:20:58 1984
                                          Year 1983 Farm 5 Fuel Type d                                              Page 1
     Equipment  Day  Mon  St. Meter  End Meter  Job   Clock Fuel Use      L/h         mph    L/100km      km/L       mpg

                                                        h

        1070     5    5        925        948   fs      23      209       9.1         2.0
                31    5        972        986   fs      14      184      13.1         2.9
                27   10          0          0   fs       0       60

                              Total Job         fs      37      453      10.6         2.3

                27    8       1067       1075    h       8       82      10.2         2.3
                30    8       1075       1090    h      15      130       8.7         1.9
                 1    9       1090       1105    h      15      128       8.5         1.9
                 4    9       1105       1110    h       5       59      11.8         2.6
                 7    9       1110       1118    h       8       73       9.1         2.0
                22    9       1125       1129    h       4       50      12.5         2.8
                24    9       1129       1141    h      12      118       9.8         2.2

                              Total Job          h      67      640       9.6         2.1

                20    9       1118       1125    o       7        0

                              Total Job          o       7        0

                 6    5        948        962    s      14      129       9.2         2.0
                 7    5        962        970    s       8      125      15.6         3.4
                 9    5        970        972    s       2       39      19.5         4.3
                 1    6        786        995    s       9      152      16.9         3.7
                 4    6        995       1003    s       8      140      17.5         3.9

                              Total Job          s      41      585      14.3         3.1

                11    6       1003       1013  swc      10      171      17.1         3.8
                20    6       1013       1020  swc       7      113      16.1         3.6
                27    6       1020       1035  swc      15      162      10.8         2.4
                25    7       1035       1053  swc      18      170       9.4         2.1
                 6    8       1053       1060  swc       7       77      11.0         2.4
                22    8       1060       1067  swc       7      114      16.3         3.6
                15   10       1141       1156  swc      15       70       4.7         1.0

                              Total Job        swc      79      877      11.1         2.4

                         Total        1070             231     2555      11.1         2.5

                                                        h

        2390     2    9        554        565    h      11      257      23.4         5.1
                 2    9        565        571    h       6       68      11.3         2.5
                 3    9        571        585    h      14       50       3.6         0.8
                 3    9        585        586    h       1      250     250.0        55.1
                 3    9        586        597    h      11      225      20.5         4.5
                 4    9        597        606    h       9      175      19.4         4.3
                 8    9        606        622    h      16      215      13.4         3.0
```

APPENDIX A-2

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                            Farm Fuel Log Detail Report
Wed Jun 27 23:20:58 1984                Year 1983 Farm 5 Fuel Type d                              Page 2

   Equipment  Day  Mon  St. Meter  End Meter  Job   Clock Fuel Use     L/h      gph   L/100km    km/L    mpg

               23    9        622        633    h      11      190    17.3      3.8
               24    9        633        642    h       9      157    17.4      3.8
               25    9        642        651    h       9      193    21.4      4.7
               26    9        651        661    h      10      200    20.0      4.4
               12   10        661        669    h       8      124    15.5      3.4

                                   Total Job    h     115     2104    18.3      4.0

               24    5        367        382    s      15      263    17.5      3.9
               25    5        382        393    s      11      258    23.5      5.2
               26    5        393        404    s      11      100     9.1      2.0
               26    5        404        405    s       1      210   210.0     46.3
               28    5        405        416    s      11      130    11.8      2.6
               28    5        416        417    s       1      187   187.0     41.2
               29    5        417        427    s      10      227    22.7      5.0
                8    6        427        440    s      13      270    20.8      4.6
               25   10        693        697    s       4      134    33.5      7.4
               25   10        697        707    s      10      258    25.8      5.7
               26   10        707        722    s      15      452    30.1      6.6

                                   Total Job    s     102     2489    24.4      5.4

               16    6        440        448  swc       8      213    26.6      5.9
               16    6        448        455  swc       7      240    34.3      7.6
               17    6        455        460  swc       5      159    31.8      7.0
               17    6        460        469  swc       9      266    29.6      6.5
                5    7        469        480  swc      11      274    24.9      5.5
                8    7        480        484  swc       4      138    34.5      7.6
               18    7        484        488  swc       4      125    31.2      6.9
               19    7        488        496  swc       8      270    33.7      7.4
               25    7        496        502  swc       6      137    22.8      5.0
               29    7        502        510  swc       8      258    32.2      7.1
               13    8        510        519  swc       9      225    25.0      5.5
               13    8        519        530  swc      11      279    25.4      5.6
               27    8        530        546  swc      16      262    16.4      3.6
               28    8        546        554  swc       8      244    30.5      6.7
               12   10        669        678  swc       9      125    13.9      3.1
               13   10        678        686  swc       8      237    29.6      6.5
               23   10        686        693  swc       7      160    22.9      5.0

                                   Total Job  swc     138     3612    26.2      5.8

                            Total       2390          355     8205    23.1      5.1

                                                        h

    non-end    11    8          0          0   fs       0        3

                                   Total Job   fs       0        3

                            Total    non-end            0        3
```

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```
                                   Farm Fuel Log Detail Report
Wed Jun 27 23:20:58 1984
                                        Year 1983 Farm 5 Fuel Type d                                                   Page 3
     Equipment  Day  Mon  St. Meter  End Meter  Job   Clock Fuel Use      L/h        mph   L/100km      km/L        mpg

                                                         h

           rt   26    5          0          0    s      0     159
                27    5       2910       2918    s      8     138       17.2        3.8
                28    5       2918       2926    s      8     140       17.5        3.9
                28    5       2932       2939    s      7     100       14.3        3.1
                29    5       2926       2932    s      6      98       16.3        3.6

                               Total Job    s          29     635       16.4        3.6

                          Total        rt              29     635       16.4        3.6

                              Fuel Total                    11398
```

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                                  Farm Fuel Log Detail Report
Wed Jun 27 23:20:58 1984                Year 1983 Farm 5 Fuel Type s                                    Page 4

    Equipment  Day  Mon  St. Meter  End Meter  Job   Clock Fuel Use      L/h      mph   L/100km      km/L      mpg

                                                       h

        auger    7    2          0          0   h      0        10
                13    7          0          0   h      0        15
                19    7          0          0   h      0        15
                27    8          0          0   h      0        15
                 4    9          0          0   h      0        10
                18   11          0          0   h      0         8
                23   11          0          0   h      0         9
                24   11          0          0   h      0        11

                                     Total Job  h      0        93

                           Total         auger         0        93

                                                       mi

         d600    6    1          0          0   h      0        30
                 8    2      15668      15690   h     22        30                     84.7       1.2        3
                 6    5      15690      15756   h     66        85                     80.0       1.2        4
                 6    6      15859      15921   h     62        79                     79.2       1.3        4
                15    6      15921      16027   h    106        57                     33.4       3.0        8
                 6    7      16124      16163   h     39        43                     68.5       1.5        4
                13    7      16163      16234   h     71        78                     68.3       1.5        4
                14    7      16234      16311   h     77        81                     65.4       1.5        4
                22    7      16311      16392   h     81        88                     67.5       1.5        4
                30    7      16392      16480   h     88        92                     65.0       1.5        4
                25    8      16480      16553   h     73        79                     67.3       1.5        4
                 2    9      16553      16594   h     41        64                     97.0       1.0        3
                 3    9      16594      16642   h     48        78                    101.0       1.0        3
                 3    9      16642      16673   h     31        52                    104.3       1.0        3
                 5    9      16673      16720   h     47        76                    100.5       1.0        3
                 8    9      16720      16786   h     66        73                     68.7       1.5        4
                23    9      16786      16835   h     49        20                     25.4       3.9       11
                24    9      16835      16837   h      2        69                   2144.2       0.0        0
                26    9      16837      16869   h     32        75                    145.7       0.7        2
                23   10      16869      16962   h     93        57                     38.1       2.6        7
                24   10      16962      17077   h    115       109                     58.9       1.7        5
                24   10      17077      17137   h     60        50                     51.8       1.9        5
                 4   11      17137      17216   h     79        79                     62.1       1.6        5
                17   11      17216      17293   h     77        75                     60.5       1.7        5
                 2   12      17293      17367   h     74        89                     74.7       1.3        4
                14   12      17367      17452   h     85        85                     62.1       1.6        5
                14   12      17452      17482   h     30        28                     58.0       1.7        5

                                     Total Job  h   1614      1821                     69.0       1.4        4

                24    5      15756      15811   s     55        76                     85.9       1.2        3
                30    5      15811      15859   s     48        84                    108.8       0.9        3

                                     Total Job  s    103       160                     96.5       1.0        3
```

APPENDIX A-2

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                              Farm  Fuel  Log  Detail  Report
Wed Jun 27 23:20:58 1984              Year 1983 Farm 5 Fuel Type g                                 Page 5

  Equipment  Day  Mon  St. Meter  End Meter  Job   Clock Fuel Use     L/h      gph   L/100km     km/L      mpg

              4    7     16027      16124    swc      97       82                      52.5       1.9        5

                                Total Job    swc      97       82                      52.5       1.9        5

                         Total       d600           1814     2063                      69.7       1.4        4

                                                      mi

       dart  12    1         0          0     t        0       35
             24    1     28507      28683     t      176       48                      16.9       5.9       17
             29    1     28683      28802     t      119       33                      17.2       5.8       16
              7    2     28802      29010     t      208       45                      13.4       7.4       21
             14    2     29010      29141     t      131       35                      16.6       6.0       17
             23    2     29141      29308     t      167       50                      18.6       5.4       15
              1    3     29308      29439     t      131       42                      19.9       5.0       14
             17    3     29439      29639     t      200       45                      14.0       7.2       20
             28    3     29639      29826     t      187       50                      16.6       6.0       17
              4    4     29826      29959     t      133       43                      20.1       5.0       14
             21    4     29959      30237     t      278       50                      11.2       8.9       25
              1    5     30237      30451     t      214       40                      11.6       8.6       24
             10    5     30451      30629     t      178       53                      18.5       5.4       15
             25    5     30629      30866     t      237       50                      13.1       7.6       22
             16    6     30866      31252     t      386       88                      14.2       7.1       20
             26    6     31252      31479     t      227       55                      15.1       6.6       19
              7    7     31479      31650     t      171       30                      10.9       9.2       26
             14    7     31650      31826     t      176       20                       7.1      14.2       40
             17    7     31826      31930     t      104       25                      14.9       6.7       19
             22    7     31930      32034     t      104       50                      29.9       3.3        9
             24    7     32034      32133     t       99       25                      15.7       6.4       18

                                Total Job     t     3626      912                      15.0       6.7       19

                         Total       dart           3626      912                      15.0       6.7       19

                                                       h

     ford t  16    7         0          0    fs        0       38
             27    7         0          0    fs        0       21

                                Total Job    fs        0       59

             23    9         0          0     h        0       26

                                Total Job     h        0       26

                         Total     ford t              0       85

                                                       h

     gard t  23    6         0          0    fs        0       10
              6    7         0          0    fs        0        6
```

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                                   Farm Fuel Log Detail Report
Wed Jun 27 23:20:58 1984                         Year 1983 Farm 5 Fuel Type g                                        Page 6
   Equipment  Day  Mon  St. Meter  End Meter  Job   Clock Fuel Use      L/h       mph   L/100km      km/L       mpg

               14    7          0          0  fs        0        9
               22    7          0          0  fs        0        6
               27    7          0          0  fs        0        5
                2    8          0          0  fs        0        2
               19    8          0          0  fs        0        9
               23    8          0          0  fs        0        1

                               Total Job      fs        0       48

                         Total    gard t                0       48

                                                       mi

      half t   31    5      53322      53519   s      197       87                      27.4       3.6        10

                                   Total Job   s      197       87                      27.4       3.6        10

               12    1          0          0   t        0       85
               10    3      51906      52092   t      186       94                      31.4       3.2         9
               21    3      52092      52176   t       84       47                      34.8       2.9         8
                4    4      52176      52437   t      261      108                      25.7       3.9        11
               18    4      52437      52710   t      273      110                      25.0       4.0        11
               11    5      52710      52996   t      286      130                      28.2       3.5        10
               24    5      52996      53309   t      313       40                       7.9      12.6        36
               24    5      53309      53322   t       13       90                     430.3       0.2         1
                5    6      53519      53634   t      115       44                      23.8       4.2        12
                7    6      53634      53873   t      239       75                      19.5       5.1        14
               15    6      53873      54146   t      273       95                      21.6       4.6        13
               29    6      54146      54400   t      254      100                      24.5       4.1        12
               17    7      54400      54732   t      332      120                      22.5       4.5        13
                1    8      54732      55035   t      303       60                      12.3       8.1        23
               10    8      55035      55160   t      125      113                      56.2       1.8         5
               27    8      55160      55438   t      278      109                      24.4       4.1        12
                8    9      55438      55656   t      218      109                      31.1       3.2         9
               26    9      55656      55915   t      259      127                      30.5       3.3         9
               11   10      55915      56095   t      180       50                      17.3       5.8        16
               20   10      56095      56275   t      180      114                      39.4       2.5         7
                8   11      56275      56565   t      290      139                      29.8       3.4         9
               24   11      56565      56683   t      118       30                      15.8       6.3        18
               26   11      56683      56801   t      118       50                      26.3       3.8        11
                3   12      56801      56920   t      119       83                      43.3       2.3         7

                                   Total Job   t     4817     2122                      26.3       3.8        11

                         Total    half t             5014     2209                      26.3       3.8        11

                                                       mi

         ihc    3    9      51087      51169   h       82       65                      49.3       2.0         6
               26    9      51169      51199   h       30       26                      53.9       1.9         5

                                   Total Job   h      112       91                      50.5       2.0         6
```

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                          Farm Fuel Log Detail Report
Wed Jun 27 23:20:58 1984                 Year 1983 Farm 5 Fuel Type g                          Page 7
    Equipment  Day  Mon  St. Meter  End Meter  Job    Clock Fuel Use     L/h      mph  L/100km     km/L      mpg

                28    5      51003      51087    s       84       68                      50.3      2.0        6
                                        Total Job    s       84       68                      50.3      2.0        6
                               Total        ihc              196      159                      50.4      2.0        6
                                                            h
      lawn m     8    6          0          0   fs        0       11
                                        Total Job   fs        0       11
                               Total     lawn m               0       11
                                                           mi
        mike     2    1          0          0    t        0       45
                16    2          0          0    t        0       50
                19    3          0          0    t        0       40
                14    4          0          0    t        0       25
                18    4          0          0    t        0       36
                22    4          0          0    t        0       15
                27    4          0          0    t        0       50
                11    5          0          0    t        0       49
                14    5          0          0    t        0       45
                18    5          0          0    t        0       40
                 1    6          0          0    t        0       33
                 5    6          0          0    t        0       28
                17    6          0          0    t        0       39
                19    6          0          0    t        0       31
                23    6          0          0    t        0       34
                24    6          0          0    t        0       37
                29    6          0          0    t        0       38
                 8    7          0          0    t        0       36
                11    7          0          0    t        0       17
                16    7          0          0    t        0       38
                17    7          0          0    t        0       35
                22    7          0          0    t        0       45
                23    7          0          0    t        0       50
                27    7          0          0    t        0       30
                31    7          0          0    t        0       43
                 1    8          0          0    t        0       29
                 7    8          0          0    t        0       42
                14    8          0          0    t        0       33
                18    8          0          0    t        0       44
                22    8          0          0    t        0       33
                 5    9          0          0    t        0       45
                11    9          0          0    t        0       24
                26    9          0          0    t        0       40
                 2   10          0          0    t        0       26
                10   10          0          0    t        0       27
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                                   Farm Fuel Log Detail Report
Wed Jun 27 23:20:58 1984                     Year 1983 Farm 5 Fuel Type s                                          Page 8
     Equipment  Dav  Mon  St. Meter  End Meter  Job    Clock Fuel Use      L/h      mph   L/100km     km/L      mpg

                 16   10          0          0   t         0       23
                 23   10          0          0   t         0       15
                 26   10          0          0   t         0       37
                 31   10          0          0   t         0       46
                  7   11          0          0   t         0       40
                 10   11          0          0   t         0       40
                 20   11          0          0   t         0       24
                 26   11          0          0   t         0       46
                  4   12          0          0   t         0       42
                 10   12          0          0   t         0       44
                 19   12          0          0   t         0       45
                 28   12          0          0   t         0       45

                                    Total Job    t         0     1719

                              Total      mike              0     1719

                                                           h

       non-eng    4    4          0          0   fs        0       15
                 18    4          0          0   fs        0       15
                 26    4          0          0   fs        0       16
                  6    5          0          0   fs        0        6
                 27    7          0          0   fs        0       22
                 23   10          0          0   fs        0       22

                                    Total Job    fs        0       96

                              Total   non-eng              0       96

                                                          mi

          nova   12    2          0          0   t         0       77
                 19    2          0          0   t         0       78
                  3    4          0          0   t         0       56
                  1    5          0          0   t         0       50
                  9    5          0          0   t         0       20
                 17    5          0          0   t         0       75
                 26    5          0          0   t         0       30
                 31    5          0          0   t         0       10
                  4    6          0          0   t         0       69
                 11    6          0          0   t         0       28
                 16    6          0          0   t         0       25
                 24    6          0          0   t         0       11
                 24    6          0          0   t         0       73
                  5    7          0          0   t         0       20
                 28    7          0          0   t         0       25
                  2    8          0          0   t         0       30
                  3    8          0          0   t         0       40
                  9    8          0          0   t         0       40
                 15    8          0          0   t         0       40
                 21    8          0          0   t         0       40
```

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                                   Farm  Fuel  Log  Detail  Report

Wed Jun 27 23:20:58 1984                        Year 1983 Farm 5 Fuel Type g                                       Page 9

     Equipment  Day  Mon  St. Meter  End Meter  Job    Clock Fuel Use      L/h       gph   L/100km      km/L       mpg

                 27    8          0          0   t         0       40
                  2    9          0          0   t         0       40
                 19    9          0          0   t         0      100
                 25    9          0          0   t         0       80
                  1   10          0          0   t         0       22
                  8   10          0          0   t         0       50
                 19   10      73901      74074   t       173       50                        18.0       5.6        16
                 26   10      74074      74295   t       221       25                         7.0      14.2        40
                 28   10      74295      74394   t        99       60                        37.7       2.7         7
                  6   11      74394      74579   t       185       46                        15.5       6.5        18
                 16   11      74579      74754   t       175       63                        22.4       4.5        13
                 30   11      74754      74973   t       219       14                         4.0      25.2        71
                  4   12      74973      75031   t        58       60                        64.3       1.6         4
                 12   12      75031      75213   t       182       68                        23.2       4.3        12
                 26   12      75213      75362   t       149       50                        20.9       4.8        14
                 30   12          0          0   t         0       25

                                     Total Job   t      1461     1630                        18.5       5.4        15

                            Total         nova          1461     1630                        18.5       5.4        15

                                                          km

          olds    4    1          0          0   t         0       80
                 12    1      77816      78202   t       386       68                        17.6       5.7        16
                 25    1      78202      78660   t       458       78                        17.0       5.9        17
                  2    2      78660      79120   t       460       80                        17.4       5.8        16
                  5    2      79120      79150   t        30       20                        66.7       1.5         4
                  7    2      79150      79758   t       608       84                        13.8       7.2        20
                 19    2      79758      80231   t       473       79                        16.7       6.0        17
                  8    3      80231      80784   t       553       86                        15.6       6.4        18
                 19    3      80784      81154   t       370       66                        17.8       5.6        16
                  4    4      81154      81601   t       447       77                        17.2       5.8        16
                 14    4      81601      82145   t       544       79                        14.5       6.9        19
                 19    4      82145      82340   t       195       29                        14.9       6.7        19
                 26    4      82340      83109   t       769       96                        12.5       8.0        23
                 17    5      83109      83620   t       511       73                        14.3       7.0        20
                 30    5      83620      84068   t       448       64                        14.3       7.0        20
                 11    6      84068      84702   t       634       71                        11.2       8.9        25
                 18    6      84702      85071   t       369       66                        17.9       5.6        16
                 23    6      85071      85588   t       517       20                         3.9      25.9        73
                 28    6      85588      85722   t       134       50                        37.3       2.7         8
                  4    7      85722      86021   t       299       67                        22.4       4.5        13
                  7    7      86021      86441   t       420       70                        16.7       6.0        17
                  8    7      86441      86853   t       412      116                        28.2       3.6        10
                 12    7      96853      87971   t      1118      166                        14.8       6.7        19
                 24    7      87971      88290   t       319       56                        17.6       5.7        16
                  5    8      88290      89133   t       843       77                         9.1      10.9        31
                 15    8      89133      89675   t       542       70                        12.9       7.7        22
                 17    8      89675      89799   t       124       18                        14.5       6.9        19
                 20    8      89799      90328   t       529       80                        15.1       6.6        19
                 26    8      90328      90530   t       202       35                        17.3       5.8        16
```

APPENDIX A-2

```
                                   Farm Fuel Log Detail Report
Wed Jun 27 23:20:58 1984                       Year 1983 Farm 5 Fuel Type g                          Page 10
     Equipment  Day  Mon  St. Meter  End Meter  Job   Clock Fuel Use    L/h      gph  L/100km     km/L    mpg

                  4    9      90530      90880   t      350      50                       14.3      7.0     20
                  8    9      90880      91030   t      150      52                       34.7      2.9      8
                 20    9      91030      91520   t      490      60                       12.2      8.2     23
                 27    9      91520      91728   t      208      50                       24.0      4.2     12
                  4   10      91728      92184   t      456      72                       15.8      6.3     18
                 13   10      92184      92723   t      539      60                       11.1      9.0     25
                 23   10      92723      93137   t      414      60                       14.5      6.9     19
                  1   11      93137      93473   t      336      72                       21.4      4.7     13
                 10   11      93473      93998   t      525      50                        9.5     10.5     30
                 14   11      93998      94259   t      261      60                       23.0      4.4     12
                 24   11      94259      94630   t      371      75                       20.2      4.9     14
                  3   12      94630      95060   t      430      79                       18.4      5.4     15
                 12   12      95060      95512   t      452      88                       19.5      5.1     14
                 18   12      95512      95920   t      408      82                       20.1      5.0     14
                 28   12      95920      96276   t      356      82                       23.0      4.3     12

                                     Total Job   t    18460    3013                       15.9      6.3     18

                                Total     olds        18460    3013                       15.9      6.3     18

                                                          h
        oliver    7    3          0          0   fs       0      72
                 11    3       7595       7601   fs       6      60    10.0      2.2
                  2    4       7601       7607   fs       6      60    10.0      2.2
                 29    4       7607       7613   fs       6      50     8.3      1.8
                 26    5       7613       7620   fs       7      62     8.9      2.0
                  9    6       7625       7631   fs       6      44     7.3      1.6
                 27    7       7648       7654   fs       6      58     9.7      2.1
                  4    8       7654       7659   fs       5      48     9.6      2.1
                  4   11       7687       7695   fs       8      67     8.4      1.8

                                     Total Job   fs      50     521     9.0      2.0

                  1    9       7659       7663   h        4      49    12.2      2.7
                  3    9       7663       7667   h        4      24     6.0      1.3
                  4    9       7667       7670   h        3      34    11.3      2.5
                 23    9       7670       7674   h        4      37     9.2      2.0
                 24    9       7674       7677   h        3      37    12.3      2.7
                 26    9       7677       7681   h        4      37     9.2      2.0

                                     Total Job   h       22     218     9.9      2.2

                 31    5       7620       7625   s        5      51    10.2      2.2
                 10    6       7631       7635   s        4      44    11.0      2.4
                 24    6       7642       7648   s        6      57     9.5      2.1

                                     Total Job   s       15     152    10.1      2.2

                 18    6       7635       7642   swc      7      72    10.3      2.3
                 12   10       7681       7687   swc      6      58     9.7      2.1
```

APPENDIX A-2

```
                                 Farm Fuel Log Detail Report
Wed Jun 27 23:20:58 1984                Year 1983 Farm 5 Fuel Type g                              Page 11
     Equipment  Day  Mon  St. Meter  End Meter  Job   Clock Fuel Use     L/h      mph  L/100km    km/L    mpg
                                     Total Job  swc     13      130     10.0      2.2
                          Total        oliver          100     1021      9.5      2.1
                                                         h
          pump    7    5          0          0  fs       0        5
                                     Total Job  fs       0        5
                 23    6          0          0  swc      0        5
                                     Total Job  swc      0        5
                          Total          pump            0       10
                                                         h
          stog   14    7          0          0  o        0       37
                                     Total Job  o        0       37
                          Total          stog            0       37
                                                         h
       swather   11    8          0          0  f        0       53
                                     Total Job  f        0       53
                 16    7          0          0  h        0       44
                 12    8          0          0  h        0       50
                 16    8          0          0  h        0       21
                 16    8          0          0  h        0       22
                 17    8          0          0  h        0       40
                 27    8          0          0  h        0       33
                                     Total Job  h        0      210
                          Total       swather            0      263
                                     Fuel Total               13369
```

APPENDIX B-1

Liquid Fuel Use and Fuel Use Rate by Equipment, 1983

Wed Jun 27 23:26:48 1984 Farm No. 5 Page 1

Equipment		Total Fuel Use L	Fuel Use Rate L/h	gph	L/100km	km/L	mpg
Diesel fuel							
Non-energy use		3					
Tractor, Case 1070, (rented)		635	16.4	3.6			
Tractor, Case 1070, 1971		2555	11.1	2.5			
Tractor, Case 2390, 1981		8205	23.1	5.1			
	Total	11398					
Gasoline							
Auger		93					
Car, Dodge Dart, 1967		912			15.0	6.7	19
Car, Nova, 1976		1630			18.5	5.4	15
Car, Oldsmobile, 1979		3013			15.9	6.3	18
Car, Valiant, 1975		1719					
Garden tractor		48					
Lawnmower		11					
Non-energy use		96					
Pump		10					
Supplied to others		37					
Swather, MF 34, 1964		263					
Tractor, Ford		85					
Tractor, Oliver S-88, 1956		1021	9.5	2.1			
Truck, 1.5 ton, IHC, 1952		159			50.4	2.0	6
Truck, 1/2 ton, Ford, 1974		2209			26.3	3.8	11
Truck, 3 ton, Dodge 600, 1974		2063			69.7	1.4	4
	Total	13369					

APPENDIX C-1

Liquid Fuel Use by Operation, 1983

Wed Jun 27 23:46:17 1984 Farm No. 5 Page 1

Operation	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Farmstead	456	18	740	26	43
Feed			53	2	2
Harvest & hauling	2744	106	2459	85	191
Seeding	3709	144	467	16	160
Summerfallow & weed control	4489	174	217	7	181
Transportation			9396	324	324
Used by others			37	1	1
Total	11398	441	13369	461	902

APPENDIX D-1

```
Use of Diesel fuel in 1983, by 10-Day Period
Wed Jun 27 23:34:39 1984          Farm No. 5                    Page 1

    Period     Litres

        13        502
        15       2010
        16        746
        17       1162
        18        162
        19        412
        20        395
        21        565
        22         77
        23        507
        24        702
        25       1630
        27        908
        29        556
        30       1064

     Total      11398
```

APPENDIX E-1

Use of Gasoline in 1983, by 10-Day Period

Wed Jun 27 23:34:39 1984 Farm No. 5 Page 2

Period	Litres
1	155
2	188
3	239
4	266
5	242
6	92
7	312
8	198
9	50
10	359
11	344
12	227
13	259
14	412
15	564
16	575
17	572
18	490
19	470
20	738
21	481
22	463
23	544
24	474
25	821
26	24
27	784
28	120
29	268
30	539
31	410
32	427
33	253
34	367
35	313
36	177
37	152
Total	13369

APPENDIX F-1

Equipment Fuel Use by Month, 1983

Wed Jun 27 23:49:11 1984

Farm No. 5

Page 1

Equipment		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Non-energy use		0	0	0	0	0	0	0	3	0	0	0	0
Tractor, Case 1070, (rented)		0	0	0	0	635	0	0	0	0	0	0	0
Tractor, Case 1070, 1971		0	0	0	0	686	738	170	403	428	130	0	0
Tractor, Case 2390, 1981		0	0	0	0	1375	1148	1202	1010	1980	1490	0	0
Auger		0	10	0	0	0	0	30	15	10	0	28	0
Car, Dodge Dart, 1967		116	130	137	93	143	143	150	0	0	0	0	0
Car, Nova, 1976		0	155	0	56	185	206	45	230	220	207	123	203
Car, Oldsmobile, 1979		226	263	152	281	137	207	475	280	212	192	257	331
Car, Valiant, 1975		45	50	40	126	134	240	294	181	109	174	150	176
Garden tractor		0	0	0	0	0	10	26	12	0	0	0	0
Lawnmower		0	0	0	0	0	11	0	0	0	0	0	0
Non-energy use		0	0	0	46	6	0	22	0	0	22	0	0
Pump		0	0	0	0	5	5	0	0	0	0	0	0
Supplied to others		0	0	0	0	0	0	37	0	0	0	0	0
Swather, MF 34, 1964		0	0	0	0	0	0	44	219	0	0	0	0
Tractor, Ford		0	0	0	0	0	0	59	0	26	0	0	0
Tractor, Oliver S-88, 1956		0	0	132	110	113	217	58	48	218	58	67	0
Truck, 1.5 ton, IHC, 1952		0	0	0	0	68	0	0	0	91	0	0	0
Truck, 1/2 ton, Ford, 1974		85	0	141	218	347	314	120	282	236	164	219	83
Truck, 3 ton, Dodge 600, 1974		30	30	0	0	245	136	464	79	507	216	154	202
	Total	502	638	602	930	4079	3375	3196	2762	4037	2653	998	995

APPENDIX G

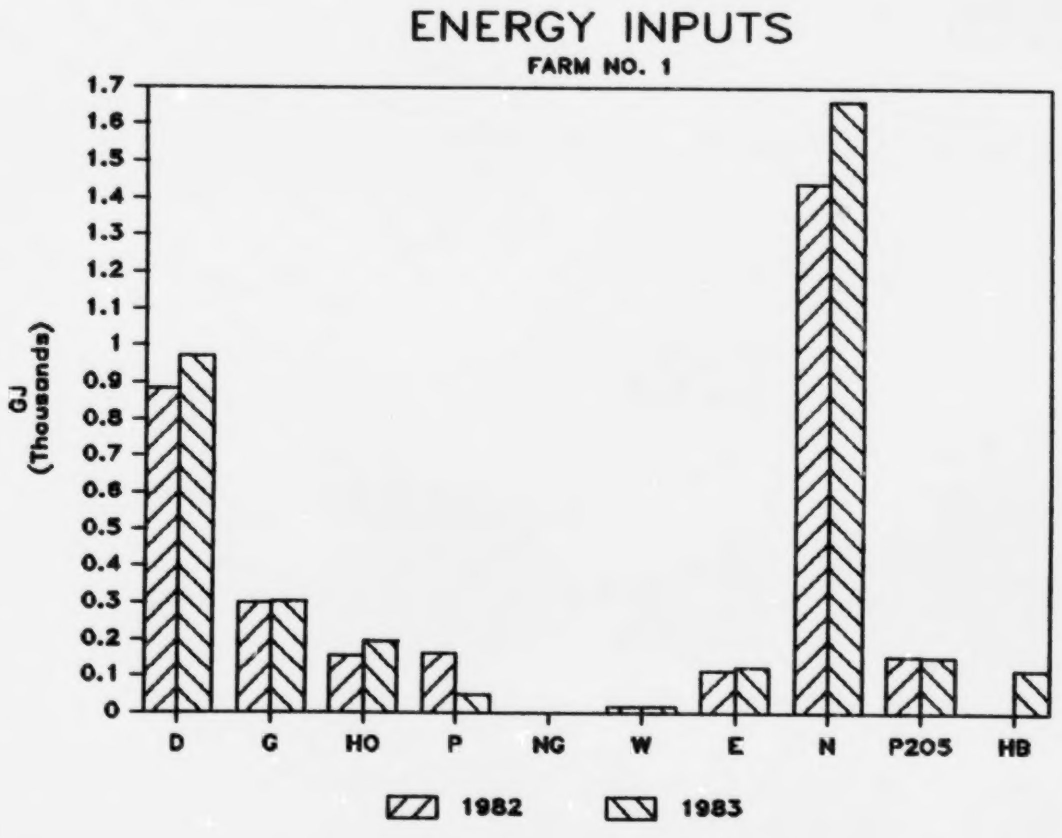
CASE STUDIES

ENERGY INPUTS FARM NO. 1

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	22806	25159	883	974
Gasoline	G	L	8697	8795	300	303
Heating Oil	HO	L	4054	5079	157	197
Propane	P	L	6432	1948	165	50
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	1100	1100	17	17
Electricity	E	kW.h	31555	34127	114	123
Nitrogen	N	kg N	23580	27272	1438	1664
Phosphorus	P205	kg P205	14280	13938	157	153
Herbicides	HB	kg AI	NR	476	NR	118

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

FARM #1
Name: Christopherson
Location: Weldon
Farm Type: Grain, Beef
Cultivated Area (ha): 571
Soil Zone: Black



FARM NO. 1 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring wheat		455	Cult (HD)	1X	✓		82-0-0	45(N)	MCPA/Banvel on		38	
					✓				315 acres			
			Rodweed	1X	✓		11-51-0	50	Hoegrass	on 140 acres		
			Hoedrill	1X	✓				Glean on	140 acres		
			Spray	1X		✓						
			Swath	1X	✓							
			Combine	1X		✓						
			Trucking									
Rape	210		Cult (HD)	1X			11-51-0	50	Treflan/Avadex			
			Rodweed	1X					Poast on	40 acres	25	10% hail in the swath
			Hoedrill	1X								
			Spray	.19X								
			Swath	1X								
			Combine	1X								
			Trucking									
Rape		80	Tandem Disc	1X			82-0-0	46(N)	Treflan/Avadex		25	
			Rodweed	1X			11-51-0	50				
			Hoedrill	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley		460	Cult (HD)	1X			82-0-0	45(N)	MCPA/Banvil			
			Rodweed	1X			11-51-0	50				
			Hoedrill	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley		100	Cult (HD)	1X			82-0-0	45(N)	MCPA/Banvil		100	
			Rodweed	1X			11-51-0	50				
			Hoegrass	1X								
			Spray	1X								
			Swath	1X								
			Silage cutter	1X								
			Trucking									
Fallow	205		Cult (HD)	2X					Treflan on 150 acres			
			Cult (LD)	8X								

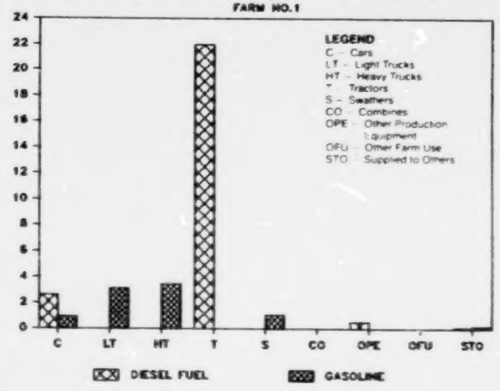
*N.B. Straw baling not included.

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 1

EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Car, Oldsmobile, 1979	2611			11.7	8.5	24
Skidsteer loader, Case 1845	507	3.3	0.7			
Supplied to others	80					
Tractor, JD 4020, 1979	752	6.7	1.5			
Tractor, JD 4430, 1973	4816	13.2	2.9			
Tractor, JD 8440, 1980	15532	28.0	6.2			
Tractor, IHC 706, 1965	861	4.5	1.0			
Total	25159					
Gasoline						
Car, Plymouth, 1976	941			17.9	5.6	16
Garden tractor	24					
Supplied to others	175					
Swather	1058					
Truck, 1/2 ton, Ford, 1976	3131			21.7	4.6	13
Truck, 3 ton, Ford, 1970	1355			63.0	1.6	4
Truck, 3 ton, Ford, 1973	2111			63.0	1.6	4
Total	8795					

LIQUID FUEL USE BY EQUIPMENT, 1983

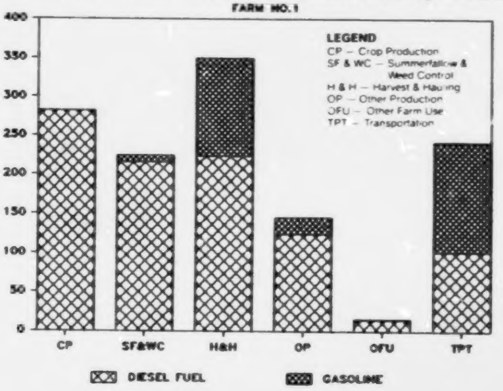


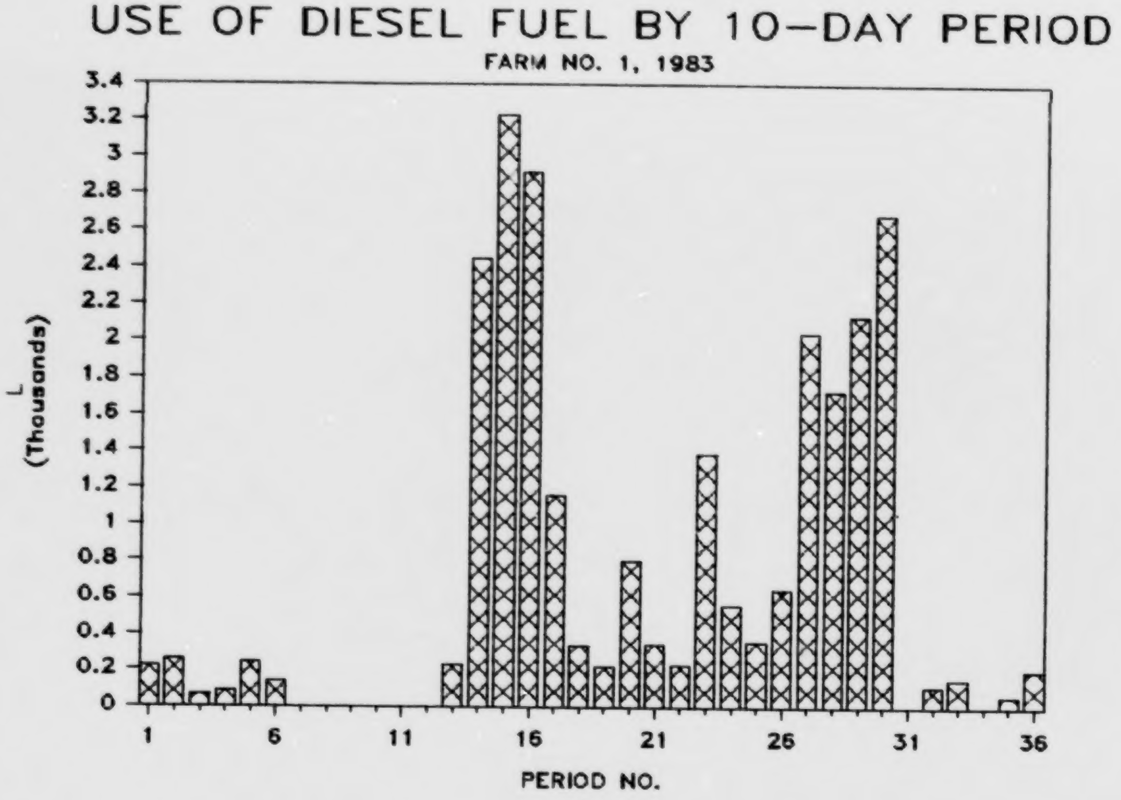
LIQUID FUEL USE BY OPERATION, 1983

Farm No. 1

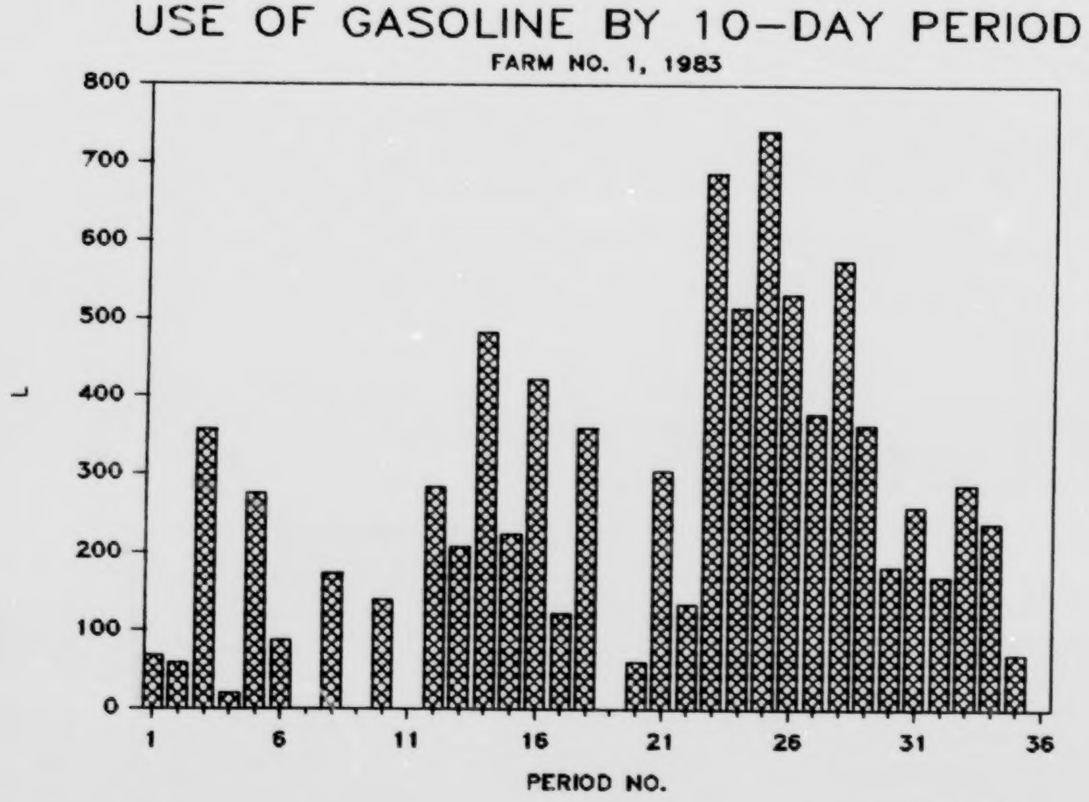
OPERATION	Diesel Fuel L	GJ	Gasoline L	GJ	Total GJ
Crop production	7295	282	0	0	282
Summerfallow & weed control	5564	215	252	9	224
Harvest & hauling	5758	223	3659	126	349
Other production	3211	124	613	21	145
Total production	21828	845	4524	156	1001
Other farm use	385	15	24	1	16
Transportation	2611	101	4072	140	242
Total farm use	24824	961	8620	297	1258
Non-farm use	335	13	175	6	19
Total	25159	974	8795	303	1277

LIQUID FUEL USE BY OPERATION, 1983




USE OF DIESEL FUEL BY 10—DAY PERIOD

FARM NO. 1, 1983


USE OF GASOLINE BY 10—DAY PERIOD

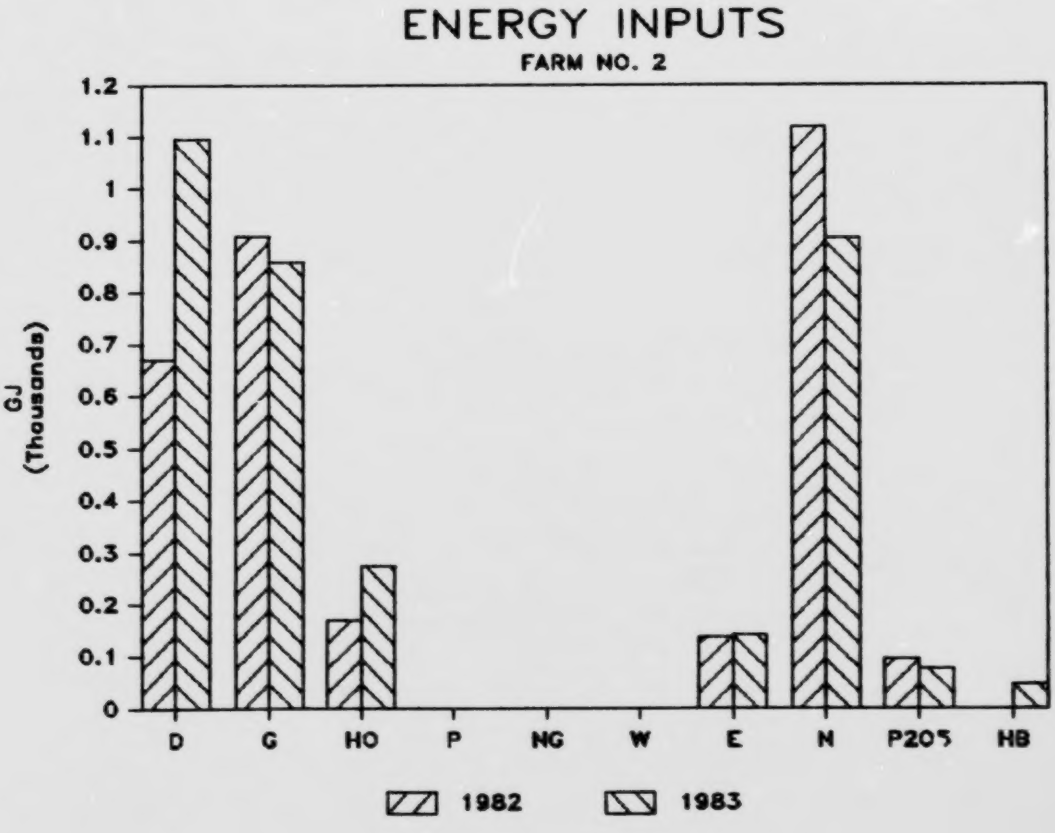
FARM NO. 1, 1983

FARM #2
Name: Sobkow
Location: Calder
Farm Type: Grain and Hay, Beef
Cultivated Area (ha): 713
Soil Zone: Black

ENERGY INPUTS FARM NO. 2

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	17294	28300	669	1095
Gasoline	G	L	26356	24887	909	859
Heating Oil	HO	L	4400	7055	170	273
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	38538	39838	139	143
Nitrogen	N	kg N	18630	15071	1118	904
Phosphorus	P205	kg P205	8800	7000	97	77
Herbicides	HB	kg AI	NR	258	NR	46

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded



FARM NO. 2 - CROP PRODUCTION PRACTICES - 1983 Sheet 1 of 2

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	G	FERTILIZER TYPE	RATE (lb/ac)	HERBICIDES TYPE	RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Barley		175	Cult (HD)	1X			82-0-0	55(N)				
			Anh Apl	1X			11-55-0	37	2,4-D and Banvil		40	
									on 125 acres			
			Cult (LD)	1X					Stampede on 50 acres			
			Press Drill	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley	55		Cult (HD)	1X							375 tonnes	
			Press Drill	1X								
			Silage	1X								
			Haul									
Oats		55	Cult (HD)	1X			82-0-0	55(N)	McPaester and		58	
									Banvil			
			Anh Apl	1X			11-51-0	37				
			Cult (LD)	1X								
			Press Drill	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Spring wheat	106		Cult (LD)	2X	✓		11-55-0	37	Avenge &	2,4-D on	36.4	slight hail
									80 acres			
			Press Drill	1X	✓							
			Harrow	1X	✓							
			Spray	1X	✓							
			Swath	1X		✓						
			Combine	1X	✓	✓						
			Trucking									burnt straw
Spring wheat		318	Anh apl	1X			82-0-0	55(N)	Avadex & Treflan		35.7	hail damage
									on 70 acres			
			Cult (LD)	1X			11-51-0	37	2,4-D Amine and			
									Banvil on 40 acres			
			Press Drill	1X								
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking	1X								
Rape	117		Spray	1X			11-55-0	33	Treflan		25	slight hail
			Cult (LD)	2X								
			Harrow	1X								
			Press Drill	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Oats	87		Cult (LD)	2X					McPaester and Banvil			
			Press Drill	1X								
			Swath	1X								
			Silage	1X							75 tonne	silage on 11 acres
			Haul	1X								
			Spray	1X								
			Combine	1X							56	
			Trucking	1X								
Clover hay and Partial ~~Fallow~~	72		Swath	1X								
			Bale	1X								
			Haul	1X								
			Cult (HD)	3X								
			Cult (LD)	1X							4200 x 60 lbs.	

FARM NO. 2 - CROP PRODUCTION PRACTICES - 1983

Sheet 2 of 2

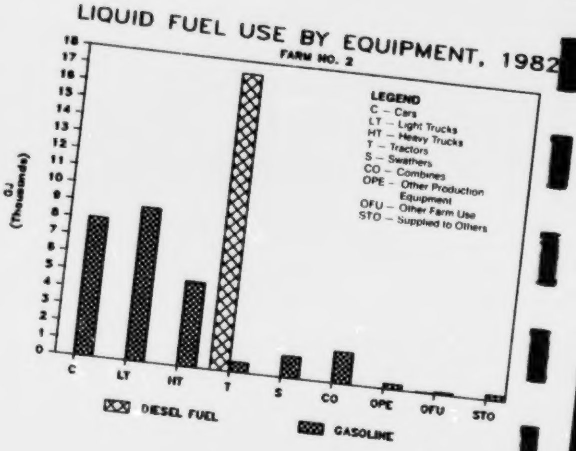
CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL		FERTILIZER TYPE	RATE (lb/ac)	HERBICIDES TYPE	RATE (oz/ac)	YIELD (bu/ac)	REMARKS
					D	G						
Br. Alf. Hay		70	Fert. Spread	1X								
			Swath	2X								
			Bale	2X							5600 x 60	lbs. square bales
			Haul	2X							2500 x 44	lbs. round bales (2nd cut)
Fallow	700		Cult (HD)	1X								
			Cult (LD)	3X								
			Rodweed	1X								

N.B. Straw baling not included.

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 2

EQUIPMENT	Total Fuel Use	-------Fuel Use Rate---------				
	L	L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Combine, MF 860, 1982	3707	21.3	4.7			
Supplied to others	261					
Tractor, IHC 1256, 1968	3794	11.9	2.6			
Tractor, IHC 3588, 1979	14662	22.5	5.0			
Tractor, IHC 706-282, 1966	2059	7.8	1.7			
Tractor, IHC 706-310, 1967	3817	8.3	1.8			
Total	28300					
Gasoline						
Auger	204					
Car, Buick Skylark, 1975	1178			15.3	6.5	18
Car, Dodge Dart, 1971	2410			19.6	5.1	14
Car, Dodge K-car, 1981	2621			9.1	11.0	31
Car, Dodge Coronet, 1975	1132			15.7	6.4	18
Car, Toyota, 1971	469			11.3	8.8	25
Combine, Cockshutt 545, 1966	657					
Lawnmower	45					
Pump	21					
Supplied to others	79					
Swather, IHC 175, 1966	40					
Swather, White 6400, 1980	2775	12.5	2.8			
Tractor, IHC 350, 1958	131	6.4	1.4			
Truck, 3 ton, Dodge, 1975	2596			65.9	1.5	4
Truck 3/4 ton, Dodge, 1979	5638			28.2	3.5	10
Truck, 4 ton, Chevrolet, 1965	311			70.0	1.4	4
Truck, Reo, 1948	383			47.0	2.1	6
Van, Dodge, 1981	4197			17.9	5.6	16
Total	24887					

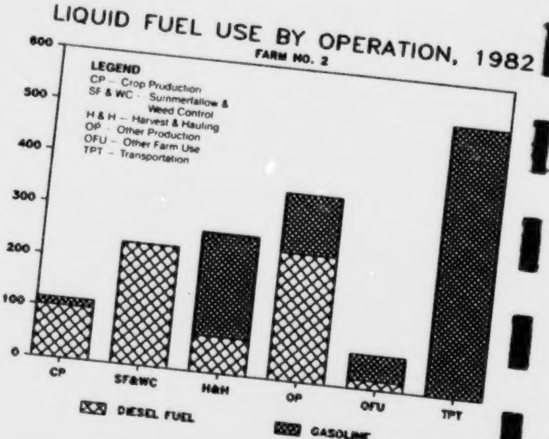

LIQUID FUEL USE BY EQUIPMENT, 1982

FARM NO. 2

LIQUID FUEL USE BY OPERATION, 1983

Farm No. 2

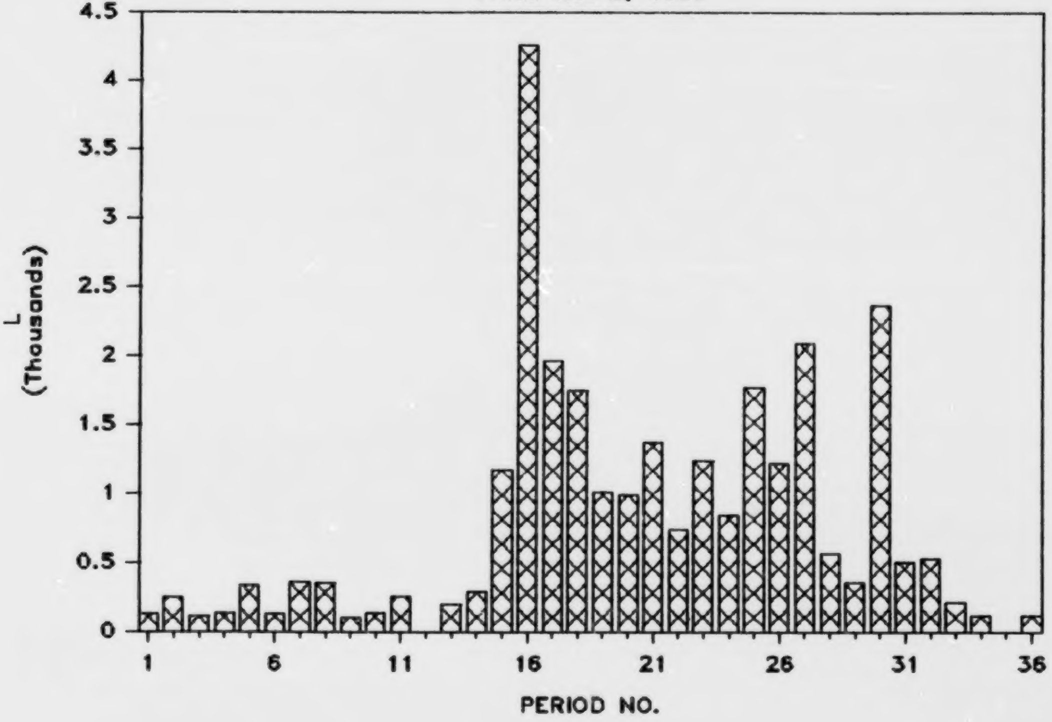
OPERATION	Diesel Fuel		Gasoline		Total
	L	GJ	L	GJ	GJ
Crop production	5472	212	440	15	227
Summerfallow & weed control	11375	440	0	0	440
Harvest & hauling	3707	143	4048	140	283
Other production	7009	271	2967	102	374
Total production	27563	1067	7455	257	1324
Other farm use	476	18	101	3	22
Transportation	0	0	17252	595	595
Total farm use	28039	1085	24808	856	1941
Non-farm use	261	10	79	3	13
Total	28300	1095	24887	859	1954


LIQUID FUEL USE BY OPERATION, 1982

FARM NO. 2

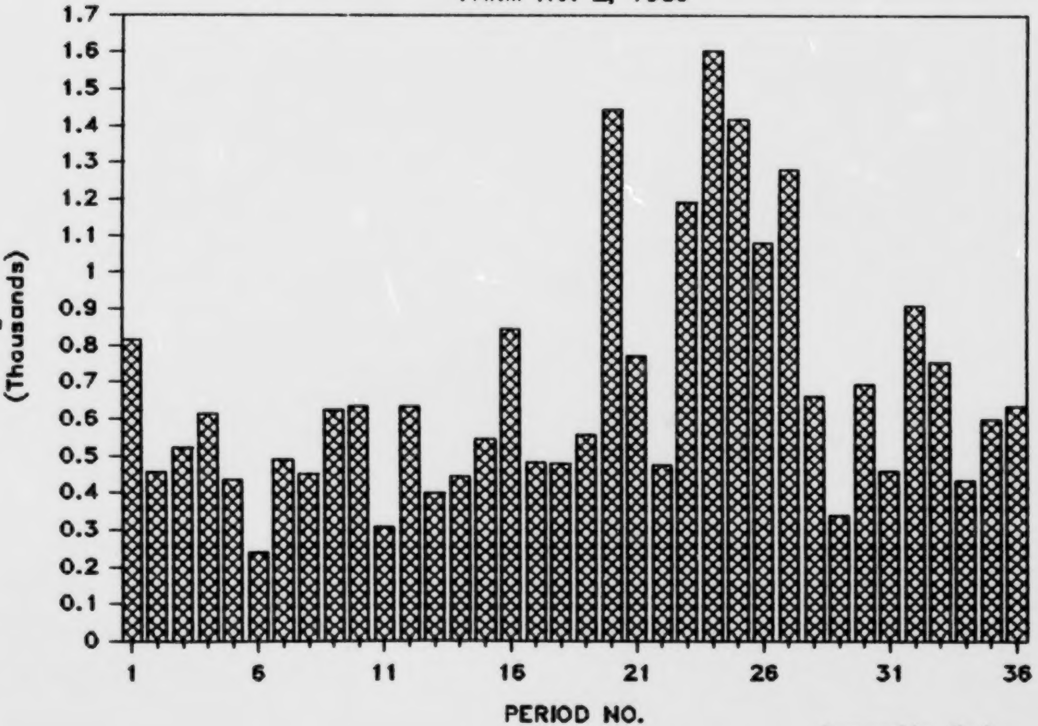
USE OF DIESEL FUEL BY 10—DAY PERIOD

FARM NO. 2, 1983



USE OF GASOLINE BY 10—DAY PERIOD

FARM NO. 2, 1983

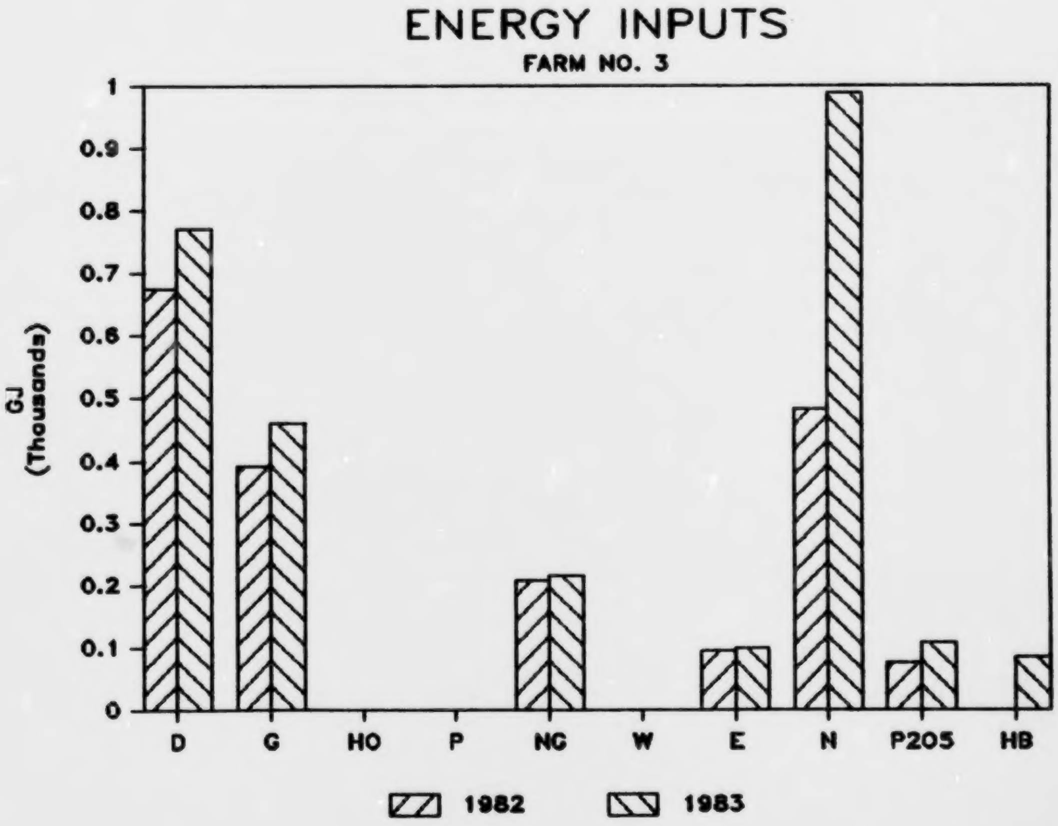


FARM #3
Name: Abrey
Location: Imperial
Farm Type: Grain
Cultivated Area (ha): 504
Soil Zone: Dk. Brown

ENERGY INPUTS FARM NO. 3

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	17459	19939	676	772
Gasoline	G	L	11350	13351	392	461
Heating Oil	HO	L	0	0	0	0
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	5589	5798	208	216
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	25960	27370	93	99
Nitrogen	N	kg N	7676	16178	484	987
Phosphorus	P205	kg P205	6720	9724	74	107
Herbicides	HB	kg AI	NR	331	NR	85

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded



FARM NO. 3 - CROP PRODUCTION PRACTICES - 1983

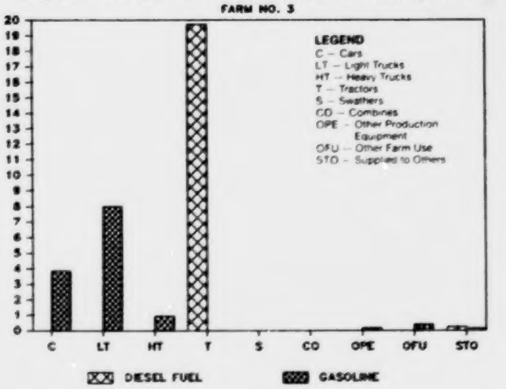
CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring wheat	30		Cult	1X			11-51-0	35	2,4-D		30	
			Hoedrill	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Spring wheat		633	Cult (HD)	1X			82-0-0	45(N)	2,4-D		30	
			Anh Apl	1X			11-51-0	35	Hoegrass on 55 acres			
			Cult (HD)	1X								
			Harrow	2X								
			Hoedrill	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley	70		Cult	1X			11-51-0	35	2,4-D		40	heat stress
			Hoedrill	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley		178	Anh. Apl.	1X			82-0-0	40(N)	2,4-D		30	heat stress
			Cult (HD)	1X			11-51-0	35				
			Hoedrill	1X								
			Spray	1X								
			Swath	1X								
			Combine									
Mustard	290		Cult	1X			11-51-0	35	Treflan		20	heat stress
			Harrow	2X								
			Hoedrill	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Mustard		45	Cult (HD)	1X			82-0-0	50(N)	Treflan		18	heat stress
			Anh. Apl.	1X								
			Cult (HD)	1X								
			Harrow	2X								
			Hoedrill	1X								
			Swath	1X								
			Combine	1X								
			Trucking									

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 3

EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Supplied to others	231					
Tractor, Cockshutt 1850, 1967	1869	10.0	2.2			
Tractor, White 4-150, 1975	17839	22.4	4.9			
Total	19939					
Gasoline						
Auger	145					
Boat	266					
Car, Mercury, 1981	3843			13.5	7.4	21
Garden tractor	91					
Supplied to others	13					
Non-energy use	100					
Truck, 1/2 ton, Ford, 1980	46			23.5	4.3	12
Truck, 3/4 ton, Chev, 1975	7939			38.0	2.6	7
Truck, 4 ton, Ford, 1964	908			77.5	1.3	4
Total	13351					

LIQUID FUEL USE BY EQUIPMENT, 1983

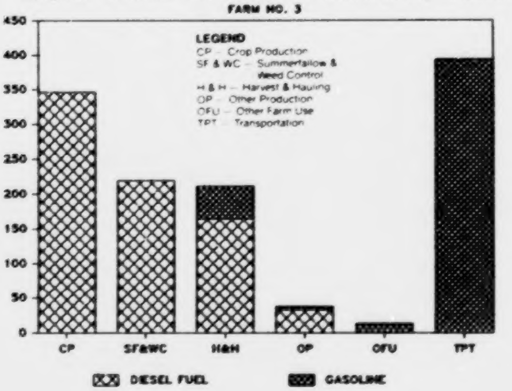


LIQUID FUEL USE BY OPERATION, 1983

Farm No. 3

OPERATION	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Crop production	8949	346	0	0	346
Summerfallow & weed control	5678	220	0	0	220
Harvest & hauling	4242	164	1351	47	211
Other production	853	33	125	4	37
Total production	19722	763	1476	51	814
Other farm use	217	0	370	13	13
Transportation	0	0	11405	393	393
Total farm use	19939	772	13251	457	1229
Non-farm use	0	0	100	3	3
Total	19939	772	13351	461	1232

LIQUID FUEL USE BY OPERATION, 1983

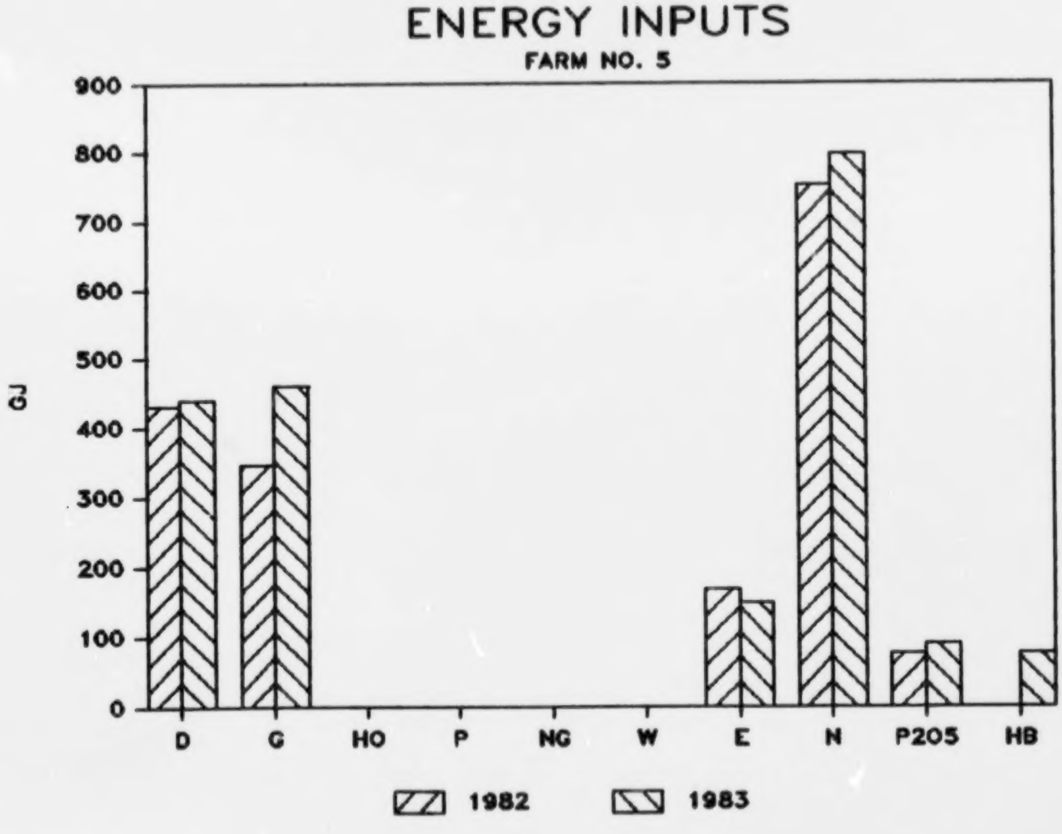


ENERGY INPUTS FARM NO. 5

FARM #5
Name: McAllister
Location: Regina
Farm Type: Grain
Cultivated Area (ha): 501
Soil Zone: Dk. Brown

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	11166	11398	432	441
Gasoline	G	L	10075	13369	348	461
Heating Oil	HO	L	0	0	0	0
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	46420	41380	167	149
Nitrogen	N	kg N	11218	10641	752	798
Phosphorus	P205	kg P205	6893	8115	76	89
Herbicides	HB	kg AI	NR	352	NR	77

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded



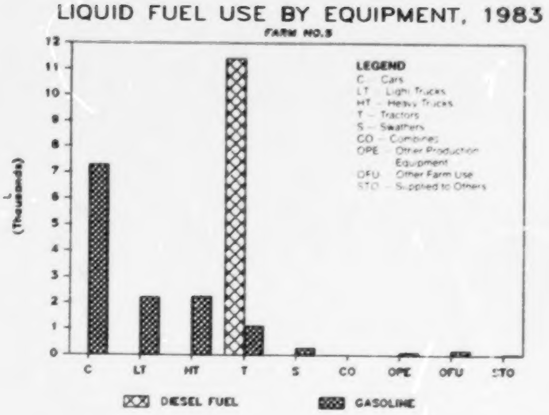
FARM NO. 5 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE (ft)	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring	415		discers	1X	✓		11-51-0	40	Avadex	16	35	Seed, fertilize with Avadex in
Wheat			harrows	2X	✓							one operation.
			sprayer	1X	✓				Banvel	1.5		
			swather	1X		✓						sp swather used to
			swather	1X	✓				MCPA	4.0		open fields only.
			combine	1X	✓							
			trucks			✓						
Spring		362	discers	1X			11-51-0	40(on all)			35	
Wheat			fert. spr	1X			34-0-0	147(on 266ac)				
			harrows	2X			46-0-0	109(on 96 ac)				
			sprayer	1X								
			swath sp	1X					2-4-D amine	6.0(on	180 acres)	
			swather	1X					Banvel	1.5	(on 185 acres)	
			combine	1X					MCPA	4.0		
			trucking									
			discers	1X			11-51-0	25			16	
Flax		82	harrows	1X								
#1			har+packer	1X								
			spray	1X					Poast (14	L on 21 ac),		
			swath	1X					(wild			
			swath	1X					oats)			
			combine	1X								
			trucking									
Flax			discers	1X			11-51-0	20	Avadex	16	16	
#2			fert.	1X			34-0-0	147				
			har/pack	1X								
			swath	1X								
			swath	1X								
			combine	1X								
			trucks									
Flax			cult (HD)	1X			Nil		Nil		Nil	Sloughs worked in fall of '82 when
#3			harrow	1X								dry. - seeded in spring '83 but
(on 44 ac. of			DD dril	1X								flooded out in summer.
sloughs)			har/pack	1X								
Lentils		54	discers	1X			11-51-0	25				Seed/fert. one operation.
			harrow	1X								
			har/pack	1X					Senco	.1715 L/ac.		
			spray	2X					Poast	1.6 L/ac.		
			swath	1X							900 lbs.	
			combine	1X							on 54 ac.	
			trucks									
Fallow	295		cult (HD)	2X								
Operations			rodweed	2X								

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 5

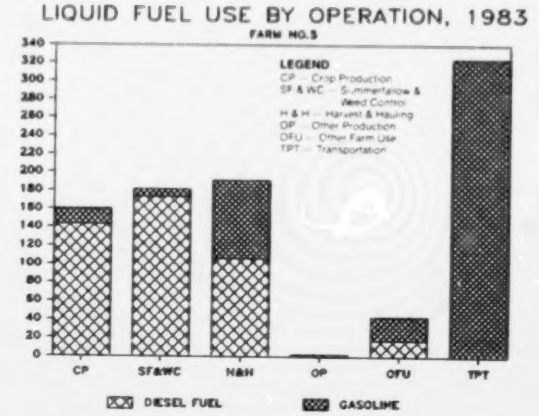
EQUIPMENT	Total Fuel Use L	-------Fuel Use Rate--------- L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Non-energy use	3					
Tractor, Case 1070 (rented)	635	16.4	3.6			
Tractor, Case 1070, 1971	2555	11.1	2.4			
Tractor, Case 2390, 1981	8205	23.1	5.1			
Total	11398					
Gasoline						
Auger	93					
Car, Dodge Dart, 1967	912			15.0	6.7	19
Car, Nova, 1976	1630			13.4	7.5	21
Car, Oldsmobile, 1979	3013			15.9	6.3	18
Car, Valiant, 1975	1719			15.7	6.4	18
Garden Tractor	48					
Lawnmower	11					
Non-energy use	96					
Pump	10					
Supplied to others	37					
Swather, MF 34, 1964	263					
Tractor, Ford	85					
Tractor, Oliver S-88, 1956	1021	9.5	2.1			
Truck, 1.5 ton, IHC, 1952	159			50.4	2.0	6
Truck, 1/2 ton, Ford, 1974	2209			26.3	3.8	11
Truck, 3 ton, Dodge 600, 1974	2063			69.7	1.4	4
Total	13369					

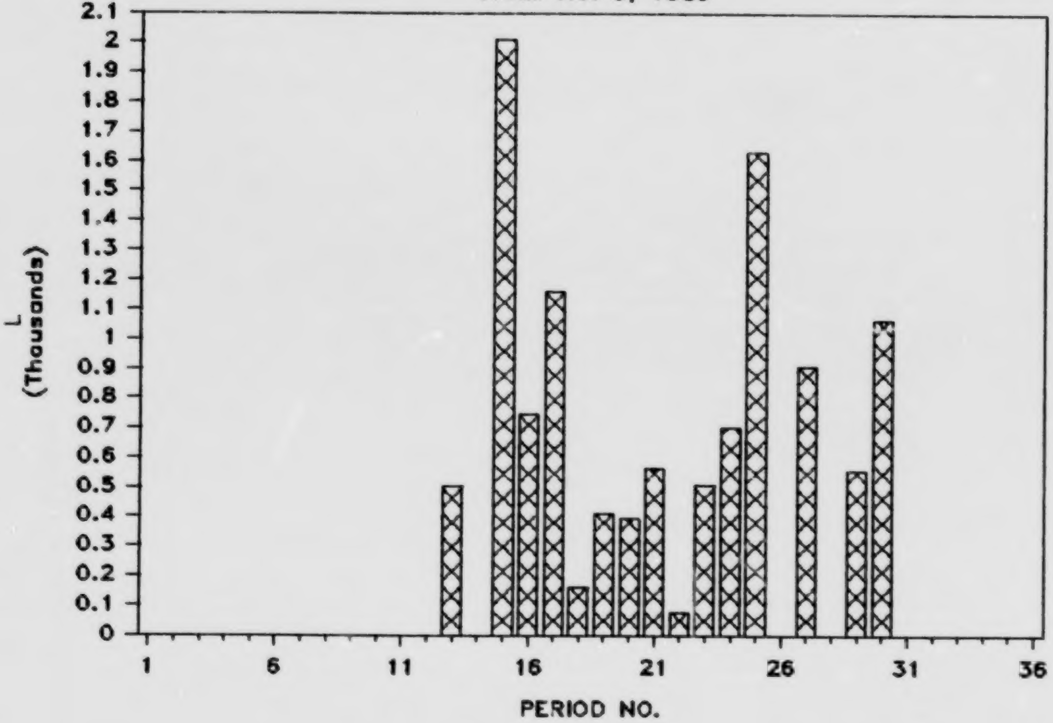


LIQUID FUEL USE BY OPERATION, 1983

Farm No. 5

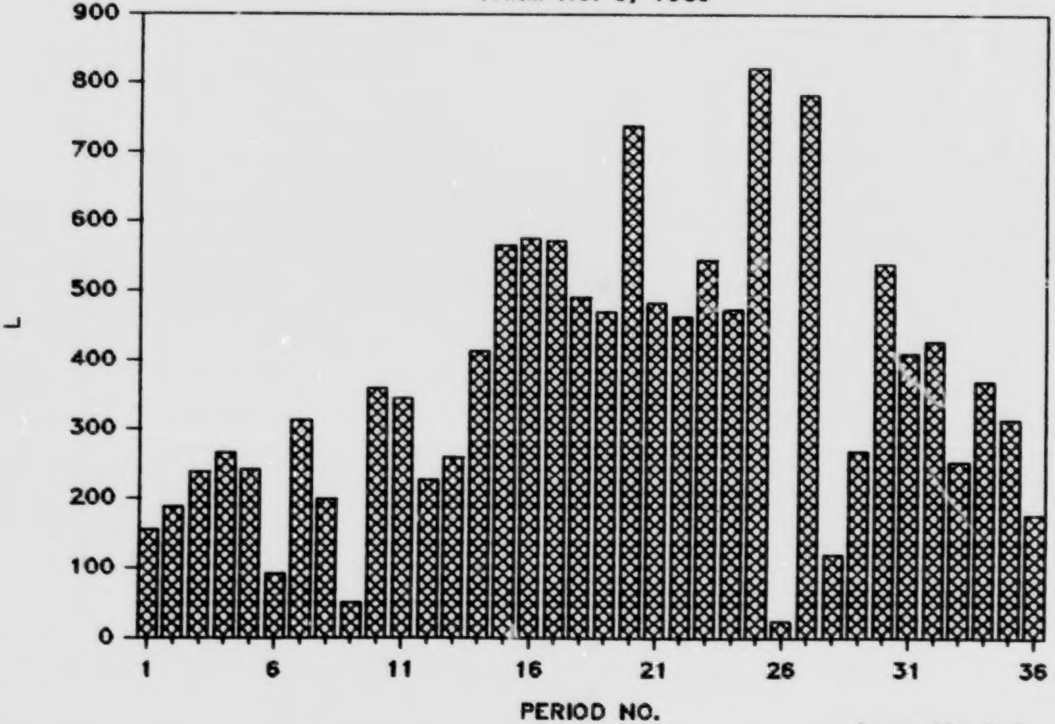
OPERATION	Diesel Fuel L	GJ	L	Gasoline GJ	Total GJ
Crop production	3709	144	467	16	160
Summerfallow & weed control	4489	174	217	7	181
Harvest & hauling	2744	106	2459	85	191
Other production	0	0	53	2	2
Total production	10942	423	3196	110	534
Other farm use	456	18	740	26	43
Transportation	0	0	9396	324	324
Total farm use	11398	441	13332	460	901
Non-farm use	0	0	37	1	1
Total	11398	441	13369	461	902





USE OF DIESEL FUEL BY 10-DAY PERIOD

FARM NO. 5, 1983



USE OF GASOLINE BY 10-DAY PERIOD

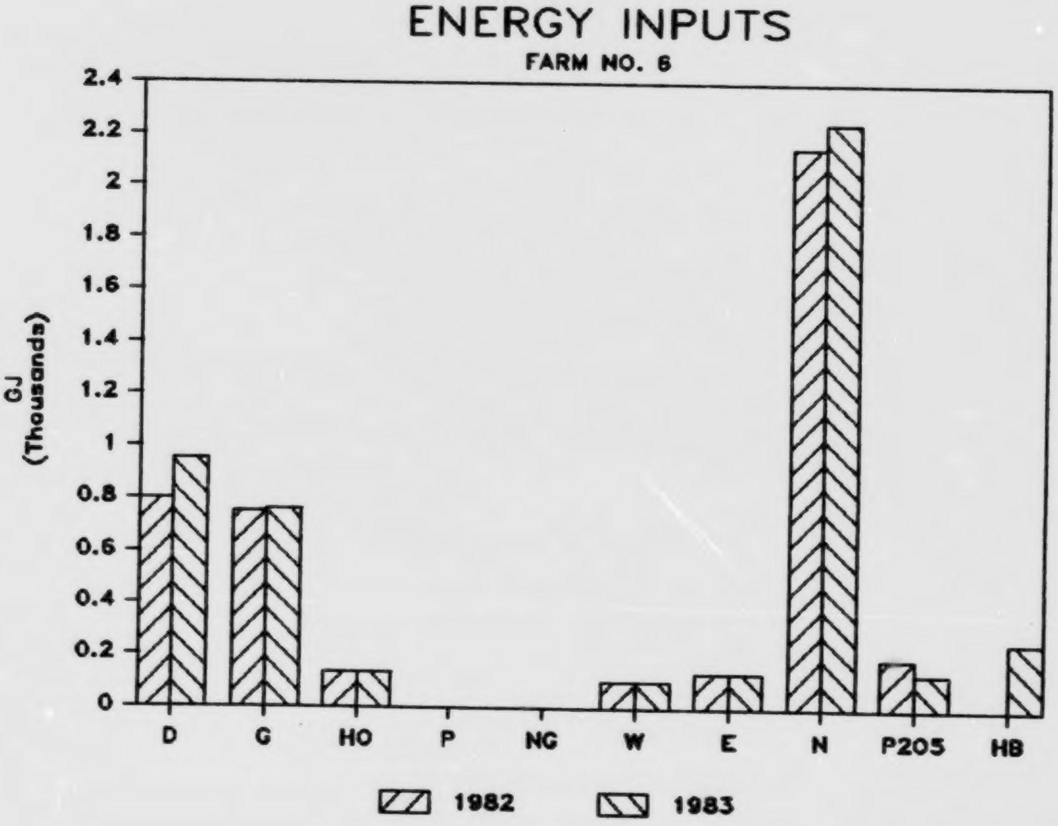
FARM NO. 5, 1983

ENERGY INPUTS FARM NO. 6

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	20684	24618	800	953
Gasoline	G	L	21796	21959	752	758
Heating Oil	HO	L	3488	3515	135	136
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	6700	6700	104	104
Electricity	E	kW.h	37661	37660	136	136
Nitrogen	N	kg N	33559	35071	2148	2245
Phosphorus	P205	kg P205	17034	12270	187	135
Herbicides	HB	kg AI	NR	949	NR	254

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

FARM #6
Name: Rice
Location: Tisdale
Farm Type: Grain and Hay, Beef
Cultivated Area (ha): 696
Soil Zone: Black (Dk. Grey)



FARM NO. 6 - CROP PRODUCTION PRACTICES - 1983

Sheet 1 of 2

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL		FERTILIZER TYPE	RATE (lb/ac)	HERBICIDES TYPE	RATE (oz/ac)	YIELD (bu/ac)	REMARKS
					D	G						
Spring wheat		444	Cult (DT)	1X			82-0-0	56(N) on 594 acres	Avadex on 444 acres		34	
		195	Anh Apl.	1X			46-0-0	40(N) on 125 acres	2,4-D ester on 90 acres			wheat midge damaged 174 acres
		85	Fert. Spread	1X			11-51-0	53 on 639 acres	Glean on 120 acres			
		85	Cult (DT)	1X					MCPA and Banvil on 429 acres			
		399	Anh Apl.	1X					Hoegrass on 50 acres			
		639	Cult (LD)	1X								
		639	Press Drill	1X								
		639	Rod Harrow Pack	1X								
		689	Spray	1X								
		639	Swath	1X								
		639	Combine	1X								
			Trucking									
Rape	180		Cult (LD)	2X			46-0-0	45(N) on 45 acres	Avadex on 45 acres		27	very wet
	45		Fert. Spread	1X			11-51-0	40 on 225 acres	Treflan on 225 acres			weeds
	45		Cult (LD)	1X					Furadan on 45 acres			disease
	45		Fert. Spread	1X								flea beetles
	45		Cult (LD)	2X								
	45		Harrow Pack	1X								
	225		Harrow Rod Pack	1X								
	225		Press Drill	1X								
	45		Spray	1X								
	225		Swath	1X								
	225		Combine	1X								
			Trucking									
Rape		80	Spread Fert.				21-0-0	63(N) on 80 acres	Treflan		23	wet year disease affected yield somewhat
		80	Cult (HD)						Post on 79 acres			
		79	Cult (HD)				82-0-0	85(N) on 79 acres				
		79	Anh Apl									
		79	Spread Fertilizer				11-51-0	53				
		79	Cult (LD)									
		159	Cult (LD)									
		159	Rod Pack Harrow									
		159	Press Drill									
		79	Spray									
		159	Swath									
		159	Combine									
			Trucking									

FARM NO. 6 - CROP PRODUCTION PRACTICES - 1983

Sheet 2 of 2

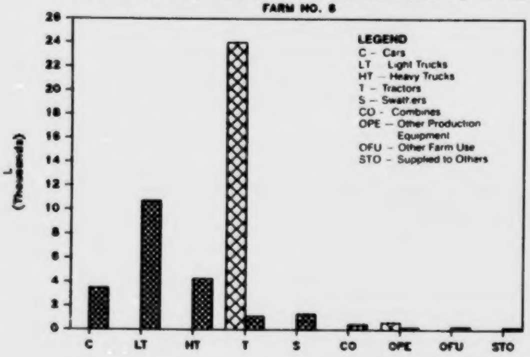
CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL		FERTILIZER TYPE	RATE (lb/ac)	HERBICIDES TYPE	RATE (oz/ac)	YIELD (bu/ac)	REMARKS
					D	G						
Flax		59	Fert. Spread				46-0-0	60(N)	Avadex		25	
			Cult (LD)				11-51-0	30	MCPA Amine			
			Rod Pack Harrow									
			Press Drill									
			Spray									
			Swath									
			Combine									
			Trucking									
Flax		110	Cult (LD)	1x			82-0-0	45(N)	Avadex		21	
			Anh Apl	1x			11-51-0	40	Buctril M			
			Cult (LD)	1x								
			Fert Spread	1x								
			Cult (LD)	1x								
			Rod Pack Harrow	1x								
			Press Drill	1x								
			Spray	1x								
			Swath	1x								
			Combine	1x								
			Trucking									
Barley		80	Cult (HD)	1x			46-0-0	45(N)	Avadex		45	*
			Fert Spread	1x			82-0-0	15(N)	MCPA			
			Cult (LD)	1x			11-51-0	50	Amine			Glume blotch and heat stress
			Anh Apl	1x								
			Cult (LD)	1x								
			Rod Harrow Pack	1x								
			Press Drill	1x								
			Spray	1x								
			Swath	1x								
			Combine	1x								
			Trucking									
Barley		82	Cult (HD)	1x			46-0-0	75(N)	Avadex		40	
			Fert Spread	1x					MCPA			
			Cult	2x								Glume blotch damage
			Harrow Pack	1x								
			Press Drill	1x								
			Spray	1x								
			Swath	1x								
			Combine	1x								
			Trucking									
Red Clover		75	Swath	1x								
			Rake	1x							1200 x 250 lbs.	
			Bale	1x								
			Haul									
Brome Alfalfa		110	Swath	2x			46-0-0	100(N)		2.25(t/acre)		
			Bale	2x								
			Haul	2x								
		80	Swath	1x								
			Bale	1x								
			Haul									
Fallow		69	Cult (LD)	6x								
		125	Cult (HD)	2x								
		125	Cult (LD)	4x								
		125	Tandem Disc	1x								

N.B. Straw baling not included.

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 6

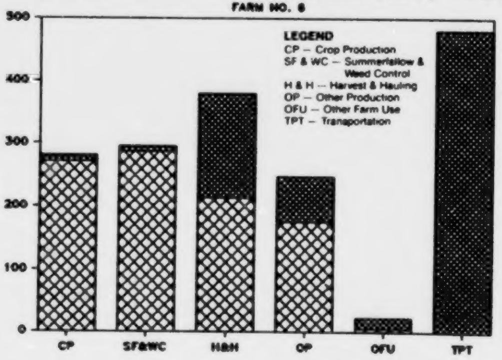
EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Grain dryer, 1966	631					
Non-energy use	4					
Tractor, Case 2290 (rented)	501	19.6	4.3			
Tractor, Deutz !006, 1969	2499	8.7	1.9			
Tractor, Deutz 13006, 1974	4899	12.5	2.8			
Tractor, Massey 90, 1960	348	4.8	1.1			
Tractor, White 2-105	4962	15.9	3.5			
Tractor, White 2-135, 1980	9645	14.3	3.1			
Tractor, White 2-155 (borr)	1129	32.8	7.2			
Total	24618					
Gasoline						
Auger	96					
Backhoe (rented)	29					
Boat	103					
Car, Chrysler, 1969	914			19.7	5.1	14
Car, Datsun, 1970	935			9.2	10.9	31
Car, Dodge Cordoba, 1983	86					
Car, Ford Escort, 1982	1568			8.7	11.5	32
Combine (rented)	455					
Lawnmower	54					
Motorcycle	19					
Pump	83					
Rototiller	9					
Snowmobile	62					
Supplied to others	210					
Swather, CCIL 550, 1979	1294					
Tractor, Ford 9N, 1948	97					
Tractor, MF 65, 1965	989	14.5	3.2			
Truck, 1 ton, Chev, 1958	180			13.0	7.7	22
Truck, 1/2 ton, Chev, 1969	690			24.4	4.1	12
Truck, 1/2 ton, Chev, 1970	1162			19.7	5.1	14
Truck, 1/2 ton, Dodge, 1982	2183			19.3	5.2	15
Truck, 3 ton, Chev, 1960	1219			35.7	2.8	8
Truck, 3 ton, Ford, 1964	1289			37.8	2.6	7
Truck, 3 ton, GMC, 1976	1552			52.1	1.9	5
Truck, 3/4 ton, Ford, 1980	6681			24.5	4.1	12
Total	21959					


LIQUID FUEL USE BY EQUIPMENT, 1983

LIQUID FUEL USE BY OPERATION, 1983

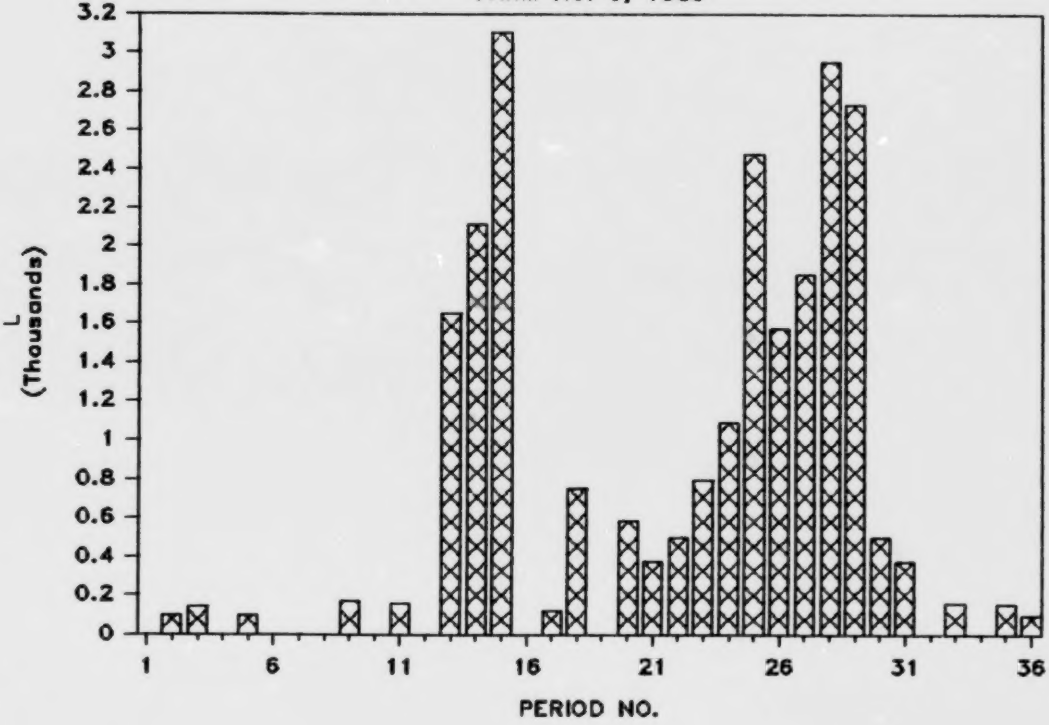
Farm No. 6

OPERATION	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Crop production	7014	271	291	10	281
Summerfallow & weed control	7406	287	246	8	295
Harvest & hauling	5532	214	4795	165	380
Other production	4537	176	2076	72	247
Total production	24489	948	7408	256	1203
Other farm use	129	5	506	17	22
Transportation	0	0	13936	481	481
Total farm use	24618	953	21850	754	1707
Non-farm use	0	0	109	4	4
Total	24618	953	21959	758	1710


LIQUID FUEL USE BY OPERATION, 1983

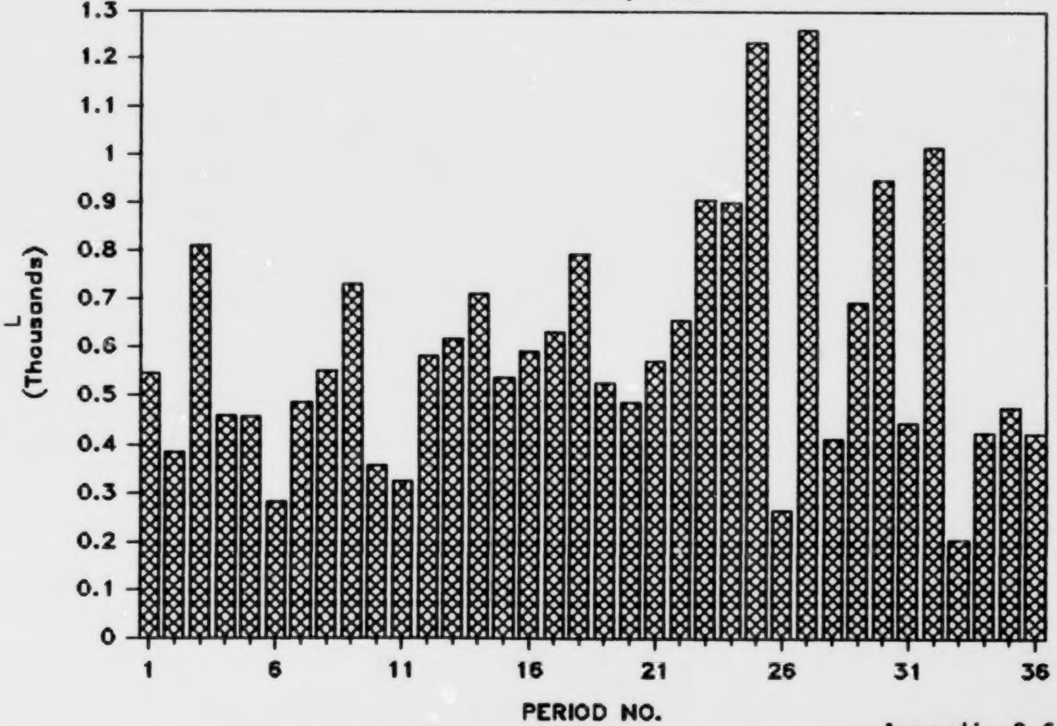
USE OF DIESEL FUEL BY 10—DAY PERIOD

FARM NO. 6, 1983



USE OF GASOLINE BY 10—DAY PERIOD

FARM NO. 6, 1983

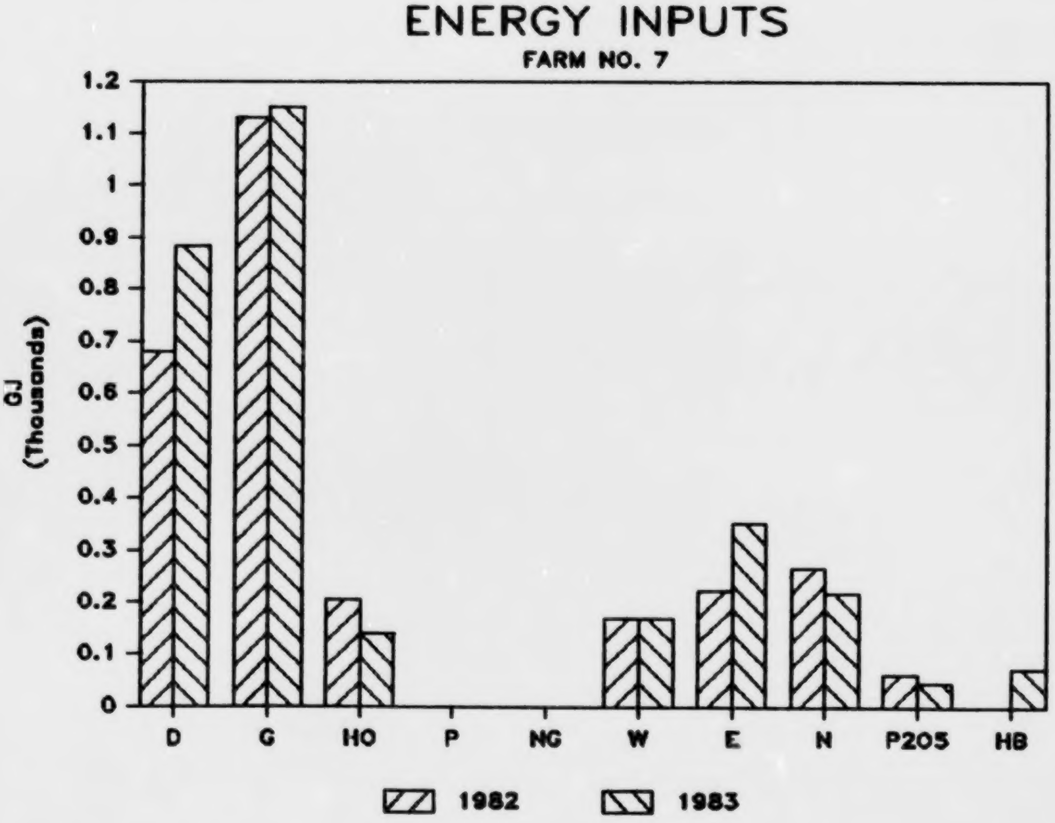


ENERGY INPUTS FARM NO. 7

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	17525	22840	678	884
Gasoline	G	L	32794	33380	1131	1152
Heating Oil	HO	L	5302	3628	205	140
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	11000	11000	171	171
Electricity	E	kW.h	61841	97951	223	353
Nitrogen	N	kg N	3510	2865	267	218
Phosphorus	P205	kg P205	5610	4310	62	47
Herbicides	HB	kg AI	NR	352	NR	74

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

FARM #7
Name: Bauml
Location: Humboldt
Farm Type: Grain, Hogs
Cultivated Area (ha): 686
Soil Zone: Black



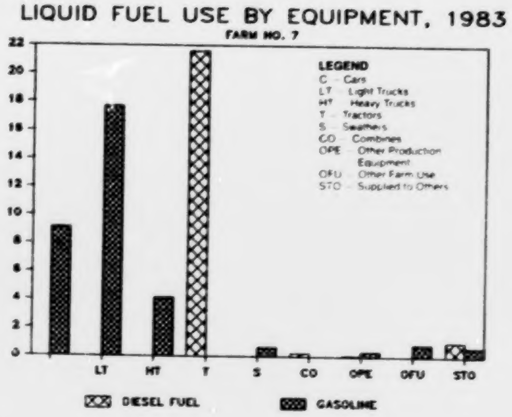
FARM NO. 7 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring wheat	372		Cult (LD)	2X	✓		11-55-0	25	2,4-D Buctril M		40-50	severe heat stress
			Press Drill	1X	✓							
			Harrow	1X	✓							
			Spray	1X	✓							Note: 100 acres had clover
			Swath	1X	✓							ploughdown
			Combine	1X	✓							
			Trucking			✓						
Spring wheat		96	Harrow	1X			46-0-0	100	Hoegrass on 44 acres			wild oat problem
			Tandem Disc	1X			11-55-0	25	Buctril M on 52 acres			
			Harrow	1X								
			Spread Fert	1X								
			Cult (LD)	2X								
			Press Drill	1X								
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking	1X								
Durum	223		Cult (LD)	2X			11-51-0	25	2,4-D Buctril		40-45	
			Press Drill	1X								
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking	1X								
Barley	227		Cult (LD)	2X					2,4-D Buctril		60-65	
			Press Drill	1X					Seed treatment			30 acres had clover ploughdown
			Harrow	1X					for smut			
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking	1X								
Fallow	670		Cult HD	4X					Avadex on 560 acres			
			Cult LD	1X								
			Harrow	1X								
Partial Fallow	90		Tandem Disc	2X								
			Cult (HD)	3X								
			Cult (LD)	1X								

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 7

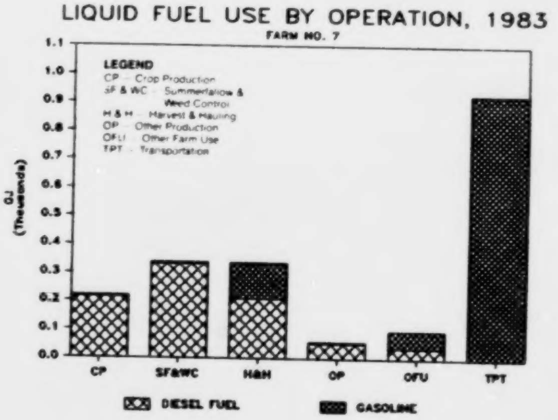
EQUIPMENT	Total Fuel Use	--------Fuel Use Rate----------				
	L	L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Combine (borrowed)	220					
Grain dryer	56					
Supplied to others	995					
Tractor, JD 1830, 1978	1609	4.4	1.0			
Tractor, JD 4440, 1980	8587	15.8	3.5			
Tractor, JD 4640, 1983	11373	23.1	5.1			
Total	22840					
Gasoline						
Auger	218					
Boat	326					
Car, Buick, 1980	4211			16.8	6.0	17
Car, Chevrolet 1974	2565			20.1	5.0	14
Car, Pontiac, 1979	2343			16.5	6.1	17
Garden tractor	24					
Generator	26					
Lawnmower	275					
Non-energy use	57					
Pump	84					
Snowmobile	131					
Supplied to others	639					
Swather, MF 756, 1980	616					
Truck, 1 ton, Dodge, 1954	219					
Truck, 1/2 ton, GMC, 1974	1871			31.6	3.2	9
Truck, 1/2 ton, GMC, 1978	3605			17.6	5.7	16
Truck, 1/2 ton, GMC, 1979	1968			22.3	4.5	13
Truck, 1/2 ton, GMC, 1982	4282			16.8	6.0	17
Truck, 1/2 ton, GMC, 1984	495			20.5	4.9	14
Truck, 3 ton, GMC, 1978	2965			42.3	2.4	7
Truck, 4x4, GMC, 1983	5458			17.8	5.6	16
Truck, tandem, GMC, 1974	961			41.0	2.4	7
Welder	41					
Total	33380					



LIQUID FUEL USE BY OPERATION, 1983

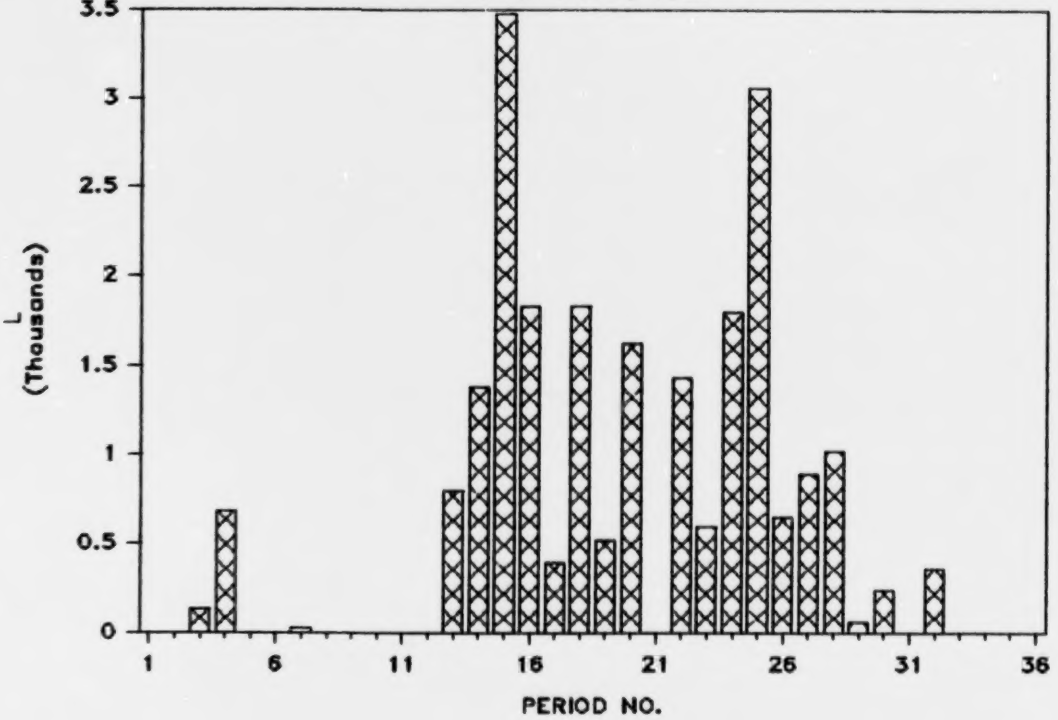
Farm No. 7

OPERATION	Diesel Fuel		Gasoline		Total
	L	GJ	L	GJ	GJ
Crop production	5575	216	145	5	221
Summerfallow & weed control	8553	331	158	5	336
Harvest & hauling	5380	208	3671	127	335
Other production	1350	52	150	5	57
Total production	20858	807	4124	142	949
Other farm use	987	38	1697	59	97
Transportation	0	0	26920	929	929
Total farm use	21845	845	32741	1130	1975
Non-farm use	995	39	639	22	61
Total	22840	884	33380	1152	2036



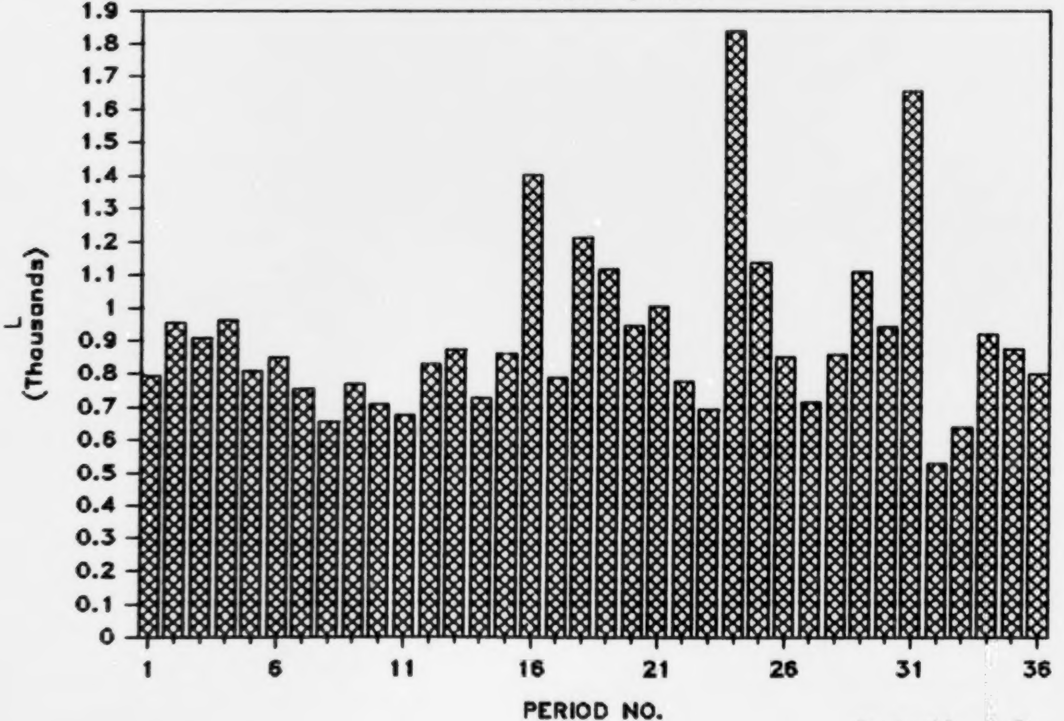
USE OF DIESEL FUEL BY 10–DAY PERIOD

FARM NO. 7, 1983



USE OF GASOLINE BY 10–DAY PERIOD

FARM NO. 7, 1983

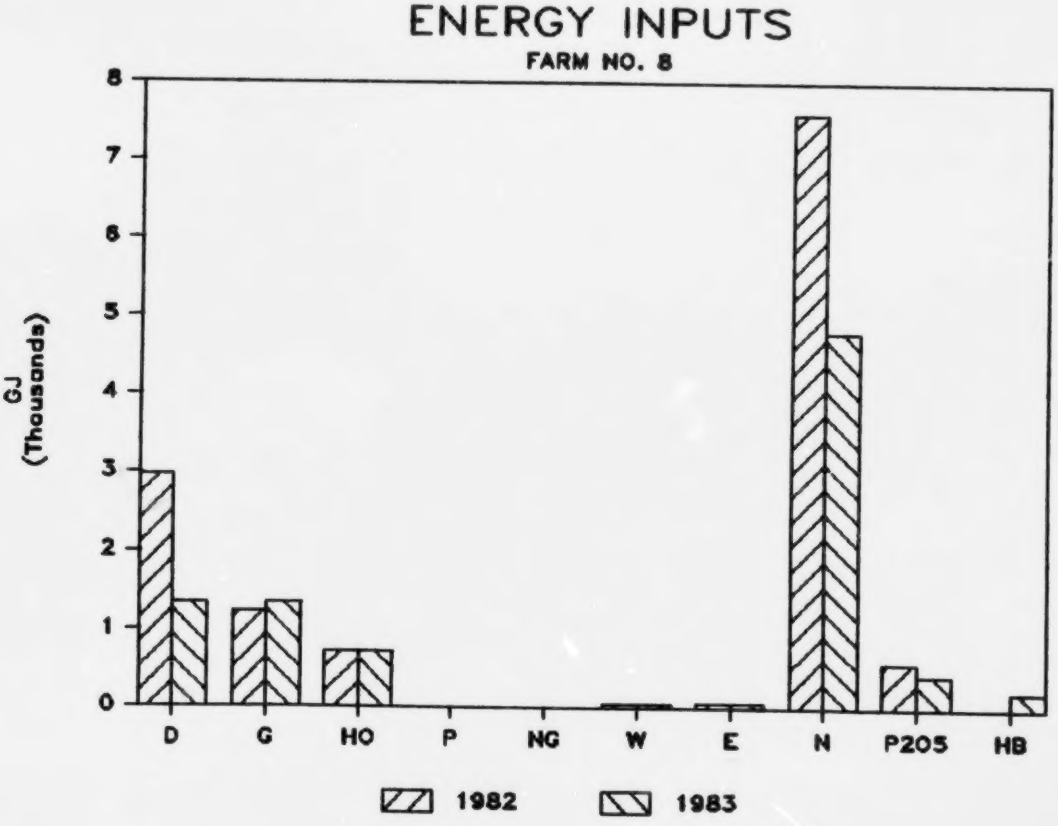


ENERGY INPUTS FARM NO. 8

FARM #8
Name: Newport
Location: Marsden
Farm Type: Grain
Cultivated Area (ha): 1219
Soil Zone: Black

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	76833	34568	2973	1338
Gasoline	G	L	35622	38982	1229	1345
Heating Oil	HO	L	18773	18773	727	727
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	2800	2800	43	43
Electricity	E	kW.h	18000	18000	65	65
Nitrogen	N	kg N	126613	64929	7597	4805
Phosphorus	P205	kg P205	52800	38897	581	428
Herbicides	HB	kg AI	NR	709	NR	211

- diesel fuel and gasoline in 1982 as metered
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded



FARM NO. 8 - CROP PRODUCTION PRACTICES - 1983

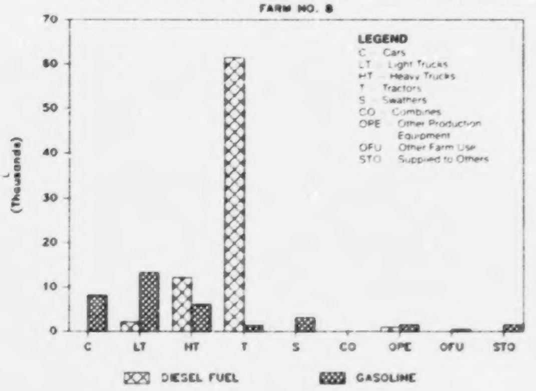
CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL		FERTILIZER TYPE	RATE (lb/ac)	HERBICIDES TYPE	RATE (oz/ac)	YIELD (bu/ac)	REMARKS
					D	G						
							Blended					
Spring wheat		1100	Cult (HD)	1X	✓		64(N) 35(P)	15(S)	Dyvel		33	320 acres ran 24 bushels/acre
			Air Seeder	1X	✓							because of sooty mold damage
			Harrow Pack	1X	✓							
			Air Seeder	1X	✓							
			Harrow Pack	1X	✓							
			Spray	1X		✓						
			Swath	1X	✓							
			Combine	1X	✓							
			Trucking			✓						
								Blended				
Barley		270	Air Seeder	1X	✓			64(N) 36(P)	15(S) Dyvel		40	
			Harrow Pack	1X	✓							
			Air Seeder	1X	✓							
			Harrow Pack	1X	✓							
			Spray	1X		✓						
			Swath	1X	✓							
			Combine	1X	✓							
			Trucking			✓						
								Blended				
Rape	350		Spray	1X	✓			64(N) 36(P)	15(S) Treflan		33	
			Air Seeder	1X	✓							
			Cult (LD)	1X	✓							
			Harrow Pack	1X	✓							
			Air Seeder	1X	✓							
			Harrow Pack	1X	✓				Malathion			
			Spray	1X		✓						
			Swath	1X	✓							
			Combine	1X	✓							
			Trucking			✓						
Rape		950	Tandem Disc	1X				64(N)36(P)	15(S) Treflan		28	
			Spray	1X								
			Airseeder	1X								
			Cult (LD)	1X								
			Harrow Pack	1X								
			Airseeder	1X								
			Harrow Pack	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking	1X								
Fallow			Cult	5X								
			Airseeder	1X								

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1982

Farm No. 8

EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Backhoe, Case 580, 1979	925	5.7	1.3			
Non-energy use	24					
Tractor, Case 2670, 1979	610					
Tractor, Case 4690-1	6340	29.4	6.5			
Tractor, Case 4890-4, 1980	6122	28.2	6.2			
Tractor, IHC 1480-1, 1981	8324	25.2	5.6			
Tractor, IHC 1480-2, 1981	7560	26.6	5.9			
Tractor, IHC 1486, 1978	1007	10.7	2.4			
Tractor, IHC 3488, 1982	1601	12.8	2.8			
Tractor, Vers 1150-1, 1982	12393	43.6	9.6			
Tractor, Vers 1150-2, 1982	17515	37.6	8.3			
Truck, 1/2 ton, Volks, 1980	2133			7.6	13.2	37
Truck, semi, Ford 9000, 1979	6287			71.9	1.4	4
Truck, tandem, IHC, 1981	5992			62.5	1.6	5
Total	76833					
Gasoline						
Auger	530					
Car, Chevrolet Z-28, 1983	705			21.4	4.7	13
Car, Ford LTD, 1979	2416			20.0	5.0	14
Car, Ford Meteor, 1976	1097			19.5	5.1	14
Car, Lincoln, 1979	3187			17.8	5.6	16
Car (?) (od.71000 @ 12/82)	848					
Lawnmower, Case 646	187					
Non-energy use	249					
Pump	96					
Spray Coupe, SC 115, 1979	857	6.7	1.5			
Supplied to others	1541					
Swather, IHC 4000, 1979	3085					
Tractor, IHC M4, 1945	224					
Tractor, IHC M6, 1945	859					
Tractor, John Deere A, 1945	267					
Truck, 1 ton, Chevrolet, 1978	1698			28.7	3.5	10
Truck, 1 ton, IHC 1310, 1970	762			54.1	1.8	5
Truck, 1/2 ton, Chev, 1972	707			23.5	4.3	12
Truck, 1/2 ton, Chev, 1978	1106			33.6	3.0	8
Truck, 1/2 ton, Chev, 1982	2518			12.1	8.3	23
Truck, 1/2 ton, Ford 1980	7308			24.5	4.1	12
Truck, 3 ton, Ford, 1962	811			56.0	1.8	5
Truck, tandem, IHC, 1978	2890			40.0	2.5	7
Van, Ford 150, 1978	1632			38.5	2.6	7
Welder	42					
Total	35622					

LIQUID FUEL USE BY EQUIPMENT, 1982

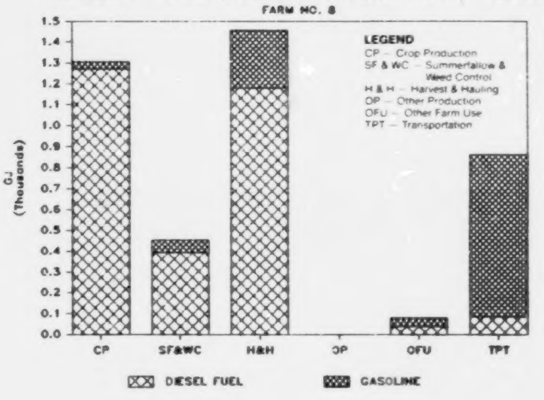


LIQUID FUEL USE BY OPERATION, 1982

Farm No. 8

OPERATION	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Crop production	32834	1271	1050	36	1307
Summerfallow & weed control	10196	395	1786	62	456
Harvest & hauling	30517	1181	8004	276	1457
Other production	0	0	0	0	0
Total production	73547	2846	10840	374	3220
Other farm use	1043	40	1142	39	80
Transportation	2243	87	22399	773	860
Total farm use	76833	2973	34381	1186	4160
Non-farm use	0	0	1241	43	43
Total	76833	2973	35622	1229	4202

LIQUID FUEL USE BY OPERATION, 1982

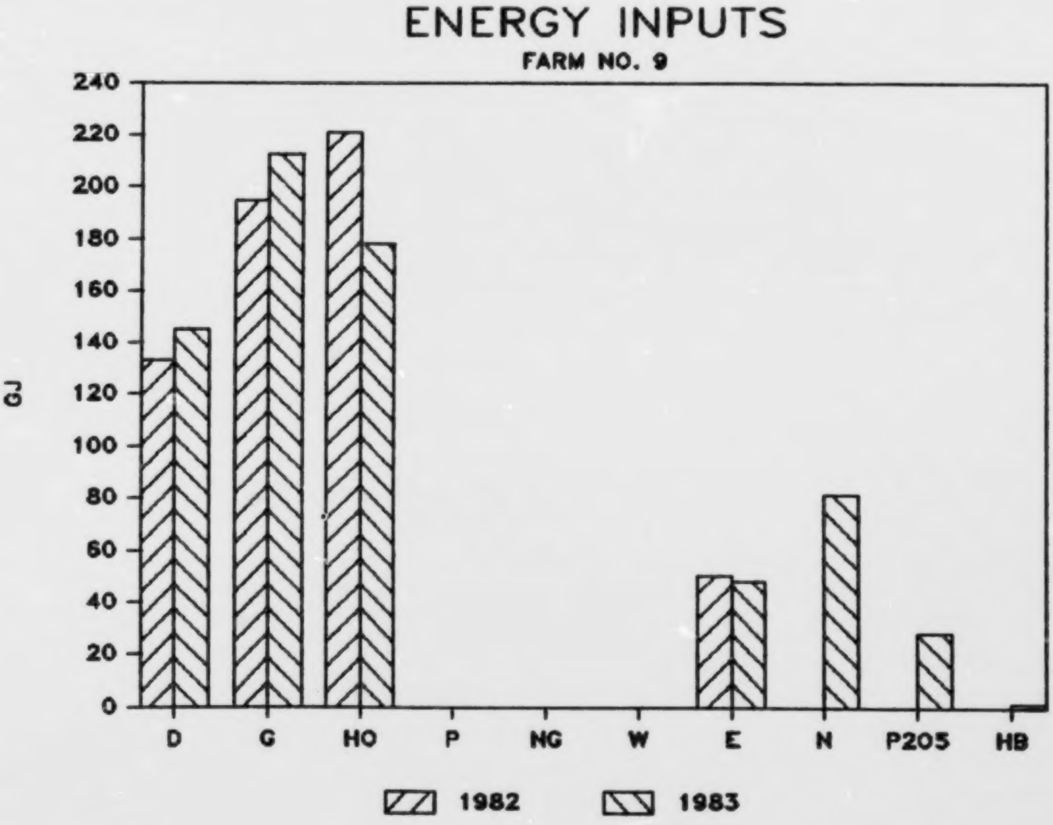


ENERGY INPUTS FARM NO. 9

FARM #9
Name: Taylor
Location: Landis
Farm Type: Grain, Sheep
Cultivated Area (ha): 312
Soil Zone: Dk. Brown

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	3439	3744	133	145
Gasoline	G	L	5641	6170	195	213
Heating Oil	HO	L	5709	4600	221	178
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	14040	13440	51	48
Nitrogen	N	kg N	0	1062	0	82
Phosphorus	P205	kg P205	0	2583	0	28
Herbicides	HB	kg AI	NR	4	NR	1

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded



FARM NO. 9 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring wheat	235		Cult (LD)	1X	✓		11-51-0	35	Hoegrass		35	
			Discer	1X	✓							
			Cult (LD)	1X	✓							
			Spray	1X	✓							
			Swath	1X	✓							
			Combine	1X	✓	✓						
			Trucking	1X	✓							
Spring wheat		50	Discer	1X			23-24-0	35			16	Severe yield loss due to heat
			Harrow (circ)	1X								stress in July
			Swath	1X								
			Combine	1X								
			Trucking									
Barley		45	Discer	1X			23-24-0	40				
			Harrow (circ)	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Oats	60		Harrow (circ)	1X			23-24-0	40				
			Cult (LD)	1X								
			Disc	1X								
			Harrow	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Hay		40	Swath	1X								
			Bale	1X								
			Haul	1X								
			Cult (HD)	2X							40-1500	lb. bales
Fallow	300		Cult (LD)	3X								
			Rodweed	3X								
Partial		40	Swath	1X							27-1500	lb. bales
Fallow			Bale	1X								
			Haul	1X								
			Cult (LD)	2X								

N.B. Straw Baling not included.

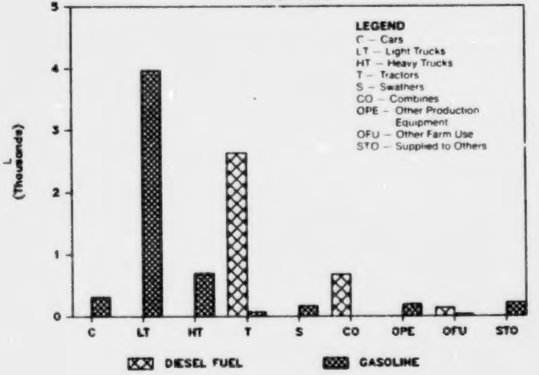
LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 9

EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Combine, CCIL M-103, 1964	918					
Non-energy use	130					
Tractor, Deutz 50, 1963	177					
Tractor, Deutz 7206, 1975	2519	5.2	1.1			
Total	3744					
Gasoline						
Auger	103					
Boat	25					
Car, Valiant (borrowed)	400			13.1	7.6	22
Lawnmower	53					
Nonenergy-use	13					
Pump	4					
Seed cleaner	72					
Supplied to others	137					
Swather, Versatile 103, 1966	160					
Tractor, Ford 8N, 1949	48					
Truck (borrowed)	50					
Truck, 1 ton, IHC, 1960	837			36.0	2.8	8
Truck, 1/2 ton, Fargo, 1968	713			20.8	4.8	14
Truck, 1/2 ton, GMC, 1976	3555			15.8	6.3	18
Total	6170					

LIQUID FUEL USE BY EQUIPMENT, 1982

FARM NO. 9



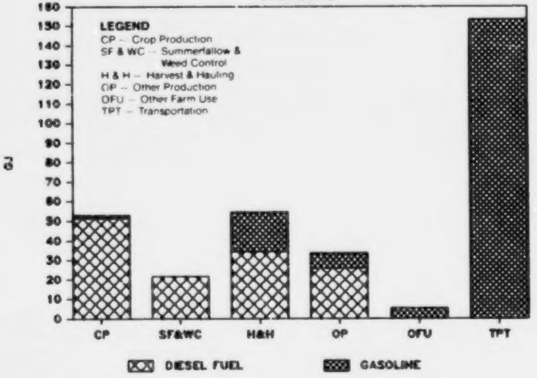
LIQUID FUEL USE BY OPERATION, 1983

Farm No. 9

OPERATION	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Crop production	1172	45	161	6	51
Summerfallow & weed control	1191	46	4	0	46
Harvest & hauling	1012	39	881	30	70
Other production	309	12	514	18	30
Total production	3684	143	1560	54	196
Other farm use	60	2	178	6	8
Transportation	0	0	4295	148	148
Total farm use	3744	145	6033	208	353
Non-farm use	0	0	137	5	5
Total	3744	145	6170	213	358

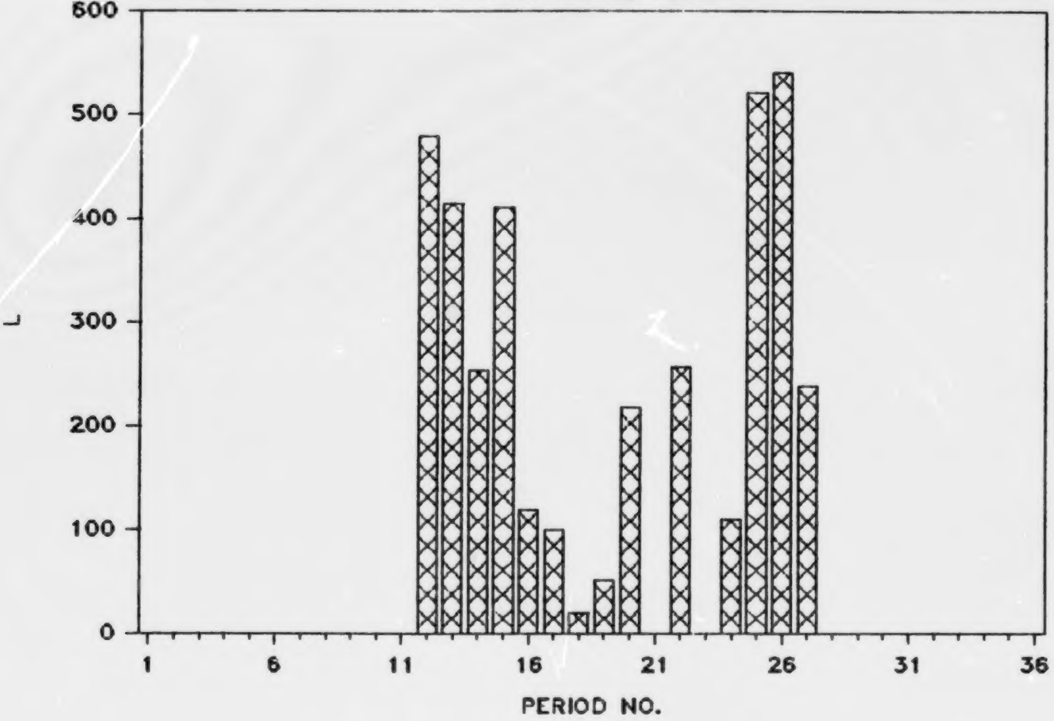
LIQUID FUEL USE BY OPERATION, 1982

FARM NO. 9



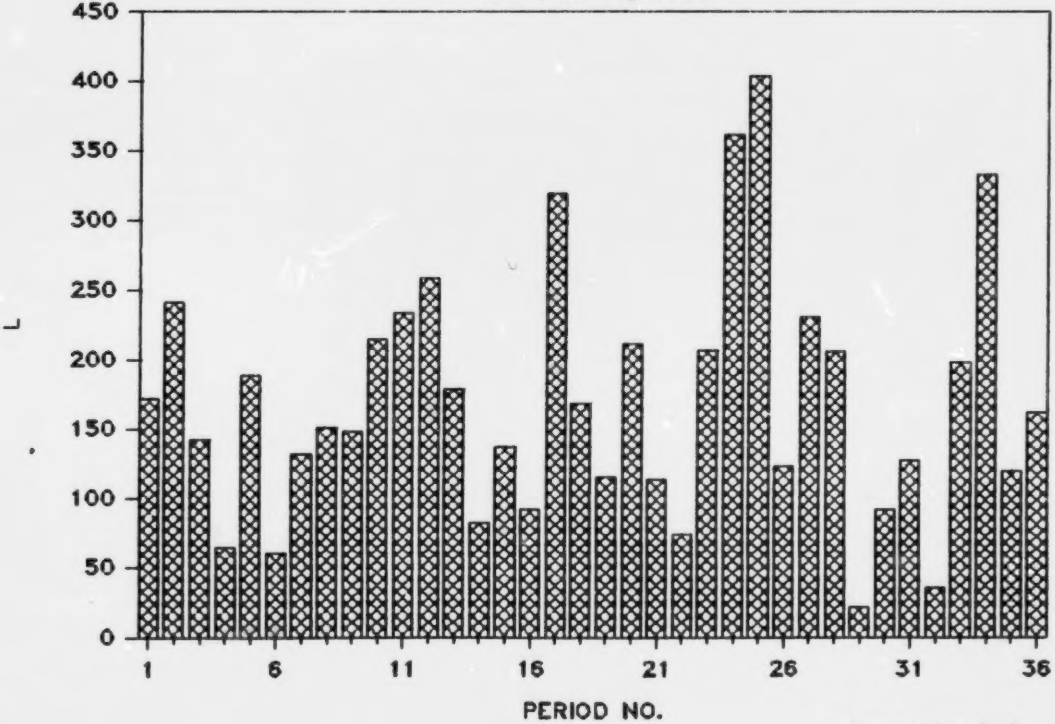
USE OF DIESEL FUEL BY 10—DAY PERIOD

FARM NO. 9, 1983



USE OF GASOLINE BY 10—DAY PERIOD

FARM NO. 9, 1983

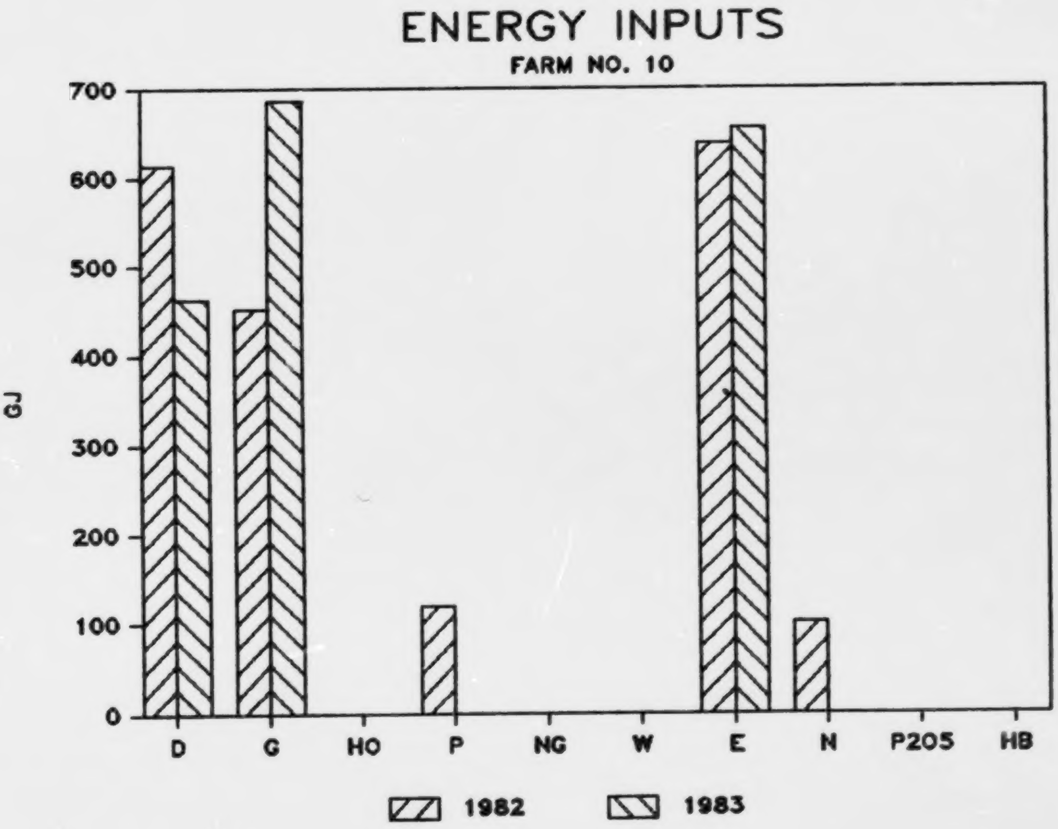


FARM #10
Name: Howse
Location: Pangman
Farm Type: Hay, Dairy
Cultivated Area (ha): 176
Soil Zone: Brown

ENERGY INPUTS FARM NO. 10

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	15866	11975	614	463
Gasoline	G	L	13123	19875	453	686
Heating Oil	HO	L	0	0	0	0
Propane	P	L	4665	0	119	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	177200	182080	638	655
Nitrogen	N	kg N	1380	0	101	0
Phosphorus	P205	kg P205	0	0	0	0
Herbicides	HB	kg AI	NR	0	NR	0

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded



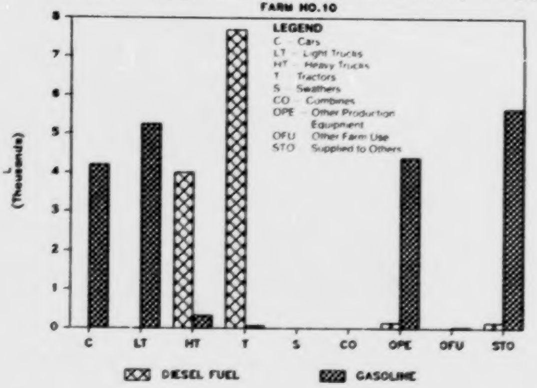
LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 10

EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Loader (borrowed)	141					
Supplied to others	138					
Tractor, Cocksh 1800, 1966	1600	8.1	1.8			
Tractor, White 105, 1979	5499	13.9	3.1			
Tractor, White 135 (rented)	597					
Truck, IHC 4070a, 1977	4000			51.0	2.0	6
Total	11975					
Gasoline						
Car, Dodge, 1979	4196			19.2	5.2	15
Non-energy use	25					
Skidsteer loader L35, 1980	4390	8.1	1.8			
Supplied to others	5642					
Tractor, Cocksh 1600, 1966	60	4.3	0.9			
Truck, 1/2 ton, Dodge, 1976	4920			20.8	4.8	14
Truck, 3 ton (rented)	319					
Truck, 3/4 ton (rented)	323			26.0	3.8	11
Total	19875					

LIQUID FUEL USE BY EQUIPMENT, 1983

FARM NO.10



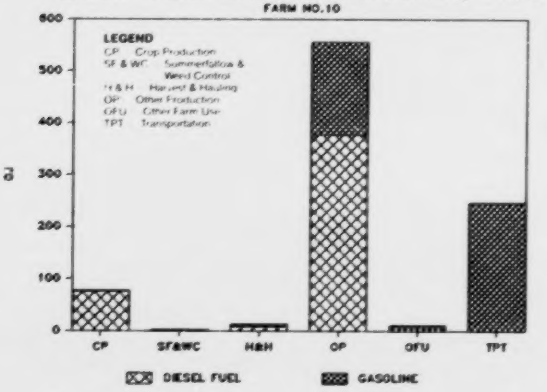
LIQUID FUEL USE BY OPERATION, 1983

Farm No. 10

OPERATION	Diesel Fuel L	GJ	Gasoline L	GJ	Total GJ
Crop production	1966	76	37	1	77
Summerfallow & weed control	50	2	0	0	2
Harvest & hauling	200	8	138	5	13
Other production	9759	378	5155	178	556
Total production	11975	463	5330	184	647
Other farm use	0	0	292	10	10
Transportation	0	0	7130	246	246
Total farm use	11975	463	12752	440	903
Non-farm use	0	0	7123	246	246
Total	11975	463	19875	686	1149

LIQUID FUEL USE BY OPERATION, 1983

FARM NO.10



ENERGY INPUTS FARM NO. 11

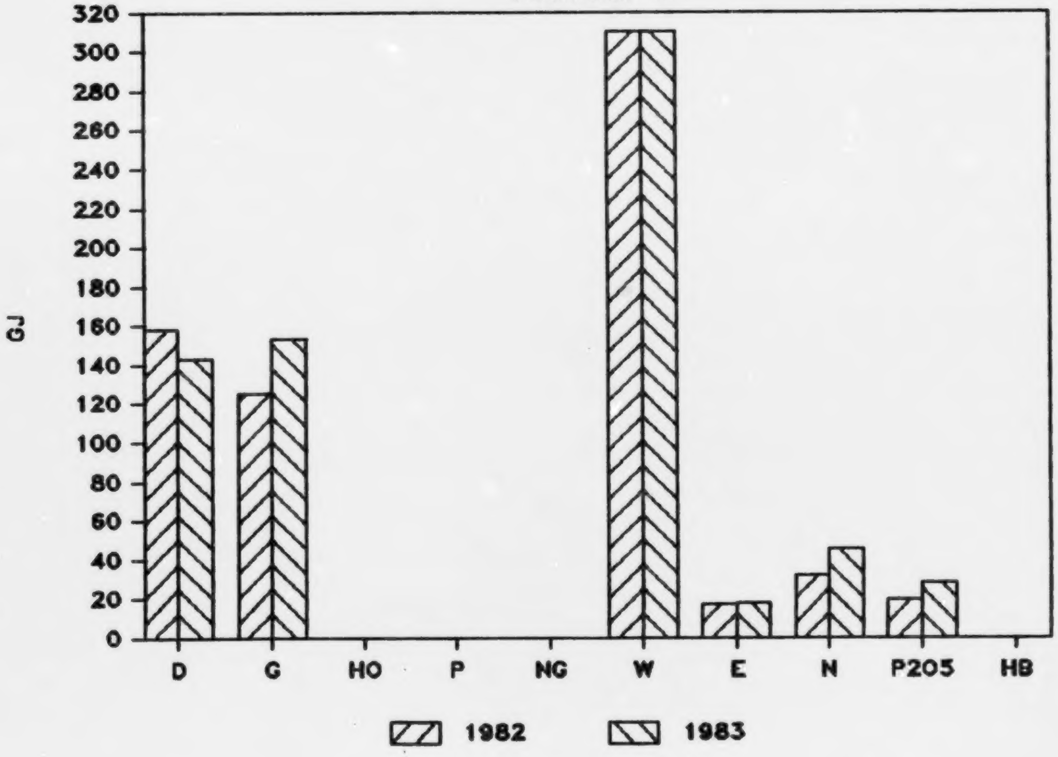
FARM #11
Name: Daniels
Location: Cochin
Farm Type: Grain and Hay
Cultivated Area (ha): 266
Soil Zone: Black

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	4090	3704	158	143
Gasoline	G	L	3626	4444	125	153
Heating Oil	HO	L	0	0	0	0
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	20000	20000	310	310
Electricity	E	kW.h	4770	4962	17	18
Nitrogen	N	kg N	385	549	32	46
Phosphorus	P205	kg P205	1785	2545	20	28
Herbicides	HB	kg AI	NR	0	NR	0

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

ENERGY INPUTS

FARM NO. 11



FARM NO. 11 - CROP PRODUCTION PRACTICES - 1983

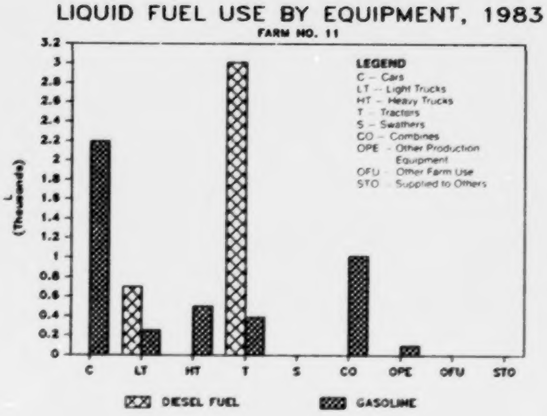
CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL		FERTILIZER TYPE	RATE (lb/ac)	HERBICIDES TYPE	RATE (oz/ac)	YIELD (bu/ac)	REMARKS
					D	G						
Spring wheat	290		Cult (HD)	1X	✓		11-51-0	44			17	Considerable hail damage
			Rodweed	1X	✓							
			Press drill	1X	✓							
			Combine	1X	✓							
			Trucking			✓						
Hay			Swath	1X							120000 lbs.	
			Bale	1X								
			Haul									
Fallow	260		Cult (HD)	3X								
			Rodweed	1X								
			Cult (HD)	1X								

N.B. Straw baling not included.

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 11

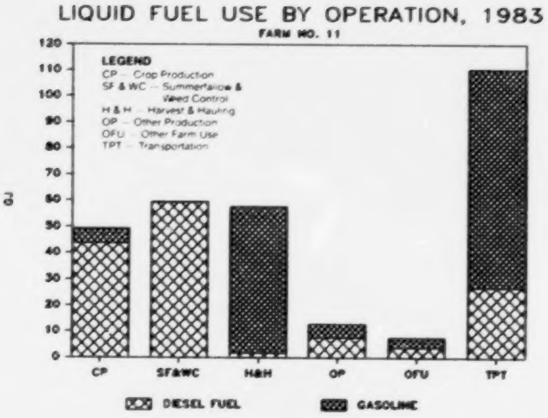
EQUIPMENT	Total Fuel Use L	-------Fuel Use Rate--------- L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Tractor, Deutz 7006, 1971	642	4.4	1.0			
Tractor, Deutz D190, 1983	2365	8.4	1.9			
Truck, 1/2 ton, GMC, 1978	697			11.3	8.8	25
Total	3704					
Gasoline						
Auger	26					
Car, Ford Pinto, 1978	1705			9.5	10.5	30
Car, Mazda, 1972	489					
Combine, Case 1000, 1961	1013					
Non-energy use	72					
Tractor, Ford-Ferguson, 1950	385					
Truck, 1/2 ton, Toyota, 1973	256					
Truck, 2 ton, IHC, 1966	498			33.0	3.0	9
Total	4444					

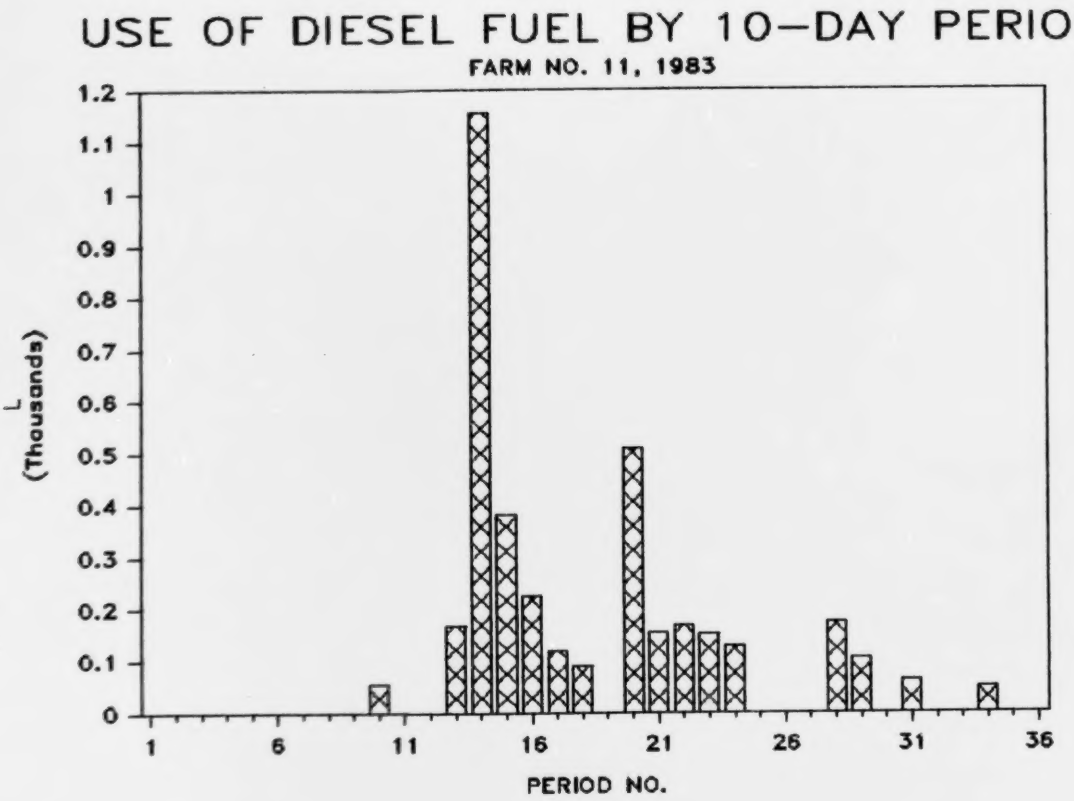

LIQUID FUEL USE BY EQUIPMENT, 1983

LIQUID FUEL USE BY OPERATION, 1983

Farm No. 11

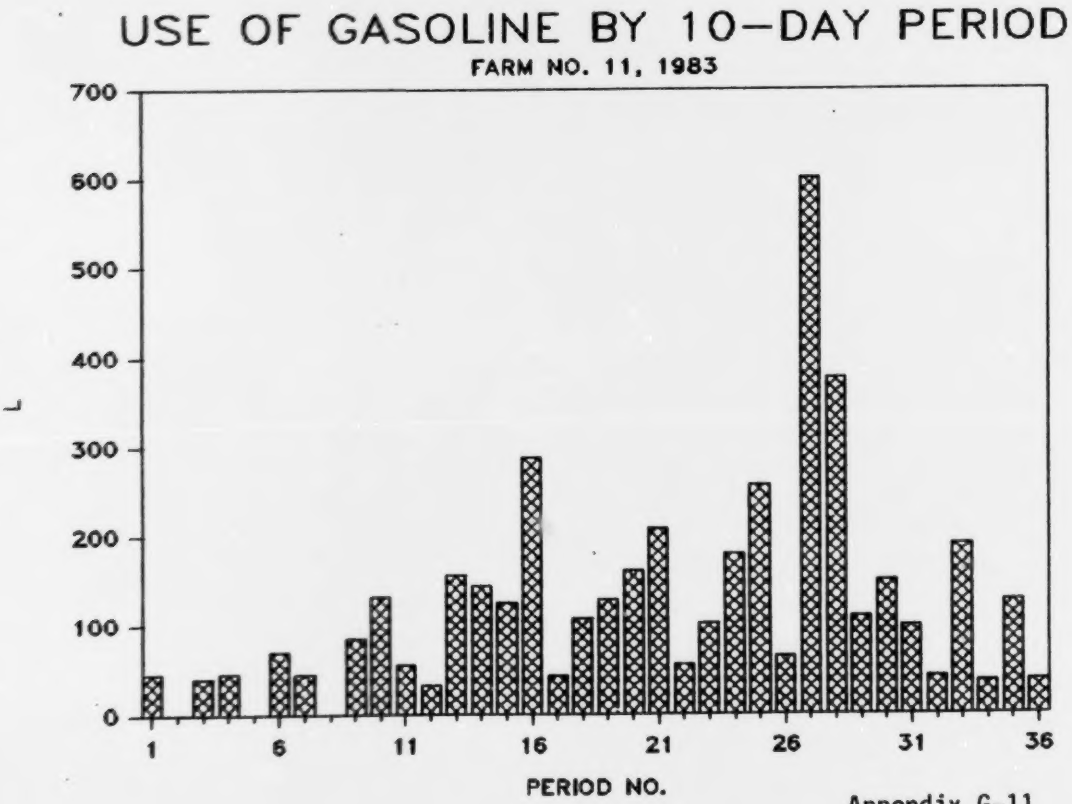
OPERATION	Diesel Fuel L	GJ	L	Gasoline GJ	Total GJ
Crop production	1128	44	162	6	49
Summerfallow & weed control	1527	59	9	0	59
Harvest & hauling	51	2	1609	56	57
Other production	200	8	141	5	13
Total production	2906	112	1921	66	179
Other farm use	101	4	110	4	8
Transportation	697	27	2413	83	110
Total farm use	3704	143	4444	153	297
Non-farm use	0	0	0	0	0
Total	3704	143	4444	153	297


LIQUID FUEL USE BY OPERATION, 1983



USE OF DIESEL FUEL BY 10—DAY PERIOD

FARM NO. 11, 1983



USE OF GASOLINE BY 10—DAY PERIOD

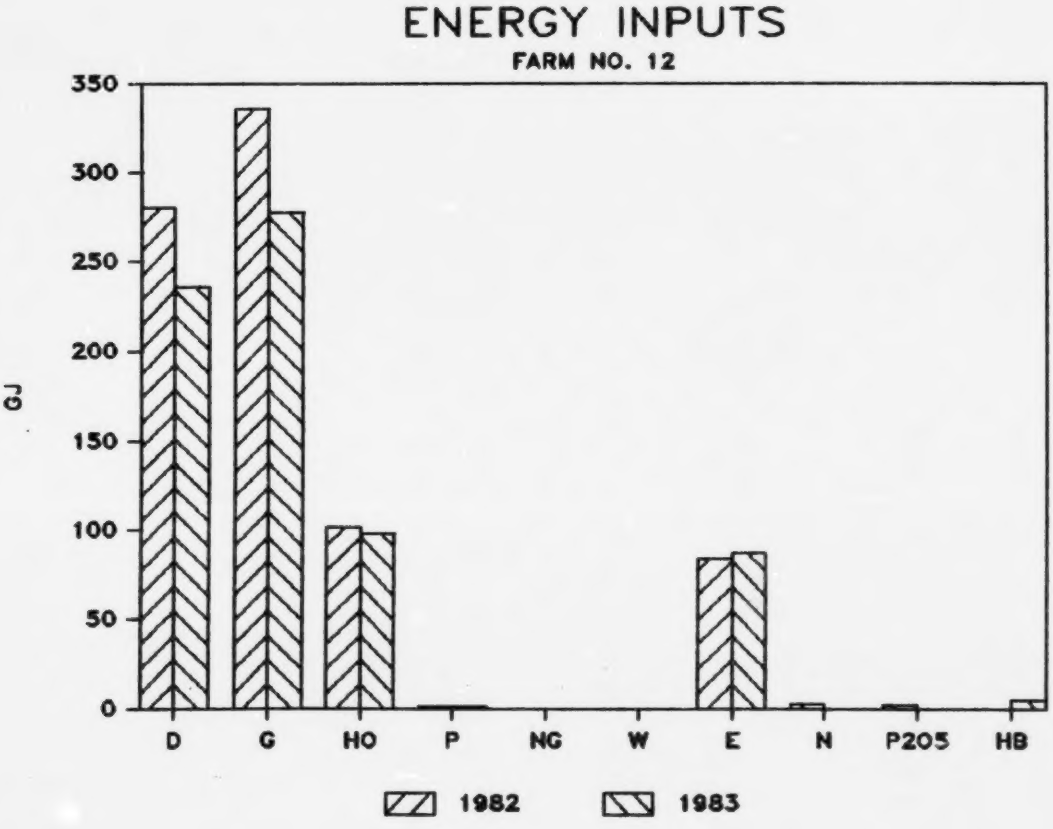
FARM NO. 11, 1983

ENERGY INPUTS FARM NO. 12

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	7250	6105	281	236
Gasoline	G	L	9735	8050	336	278
Heating Oil	HO	L	2623	2534	102	98
Propane	P	L	56	54	1	1
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	23307	24303	84	87
Nitrogen	N	kg N	36	0	3	0
Phosphorus	P205	kg P205	165	0	2	0
Herbicides	HB	kg AI	NR	35	NR	5

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- this farm also used a number of "organic" fertilizers
- NR = not recorded

FARM #12
Name: Puetz
Location: Humboldt
Farm Type: Grain and Hay, Beef
Cultivated Area (ha): 180
Soil Zone: Black



FARM NO. 12 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	G	FERTILIZER TYPE	RATE (lb/ac)	HERBICIDES TYPE	RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring wheat	32		Cult (DT) Harrow pack	1X	✓				2,4-D		30	
			Seedrite	1	✓				Hoegrass	on 9 acres		
			Spray	1.27	✓							
			Swath	1X		✓						
			Combine	1X	✓							
			Trucking			✓						
Spring wheat		40	Cult (DT) Packer Harrow	1X					2,4-D		15	
			Seedrite	1X					Javex			
			Rodweed	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley	65		Harrow Cult	1X					2,4-D		55	
			Seedrite	1X					Hoegrass			
			Rodweed	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Durum	42		Cult Packer-Harrow	1X					2,4-D		29	
			Seedrite	1X					Hoegrass			
			Spray	1.36X								
			Swath	1X								
			Combine	1X								
			Trucking									
Sweet Clover	15		Swath	1X							7000	
			Combine	1X								
			Trucking	1X								
Partial Fallow		95	Double Disc Harrow	2X								
			Cult	1X								
			Rodweed	1X								
Fallow	40		Cult Harrow	3X								
			Rodweed	1X								
Fallow	46		Cult Harrow	2X								
			Rodweed	1X								
Partial		12	Swath	1X							1500 x 15 round bales	
Fallow		12	Bale	1X								
		25	Double Disc	2X								
		25	Rodweed	1X								

N.B. Straw baling not included.

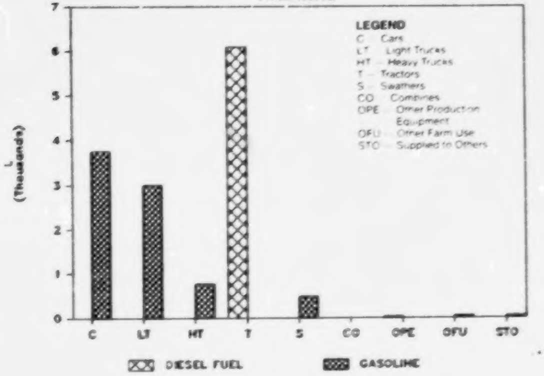
LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 12

EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Sprayer	30					
Tractor, Deutz DX110 (rented)	223					
Tractor, Deutz DX130, 19..	3524	10.6	2.3			
Tractor, JD 2130, 1976	840	4.2	0.9			
Tractor, JD 4230, 1974	1298	13.7	3.0			
Tractor, JD 4240 (demo)	190					
Total	6105					
Gasoline						
Car, Chevrolet Malibu, 1978	3748			18.9	5.3	15
Garden tractor	39					
Supplied to others	34					
Swather, CCIL, 1966 (rent)	480					
Truck, 1.5 ton, GMC, 1954	191			35.3	2.8	8
Truck, 1/2 ton, GMC, 1971	2988			20.3	4.9	14
Truck, 3 ton, GMC, 1964	570			34.6	2.9	8
Total	8050					

LIQUID FUEL USE BY EQUIPMENT, 1983

FARM NO.12



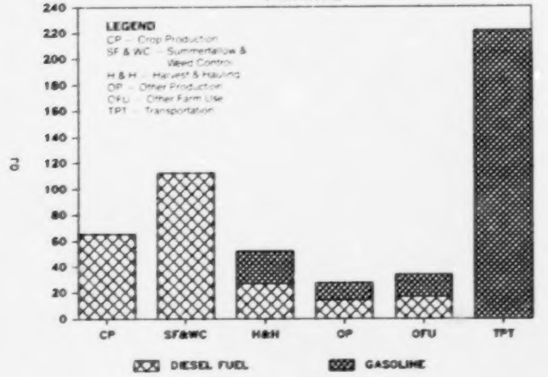
LIQUID FUEL USE BY OPERATION, 1983

Farm No. 12

OPERATION	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Crop production	1686	65	0	0	65
Summerfallow & weed control	2901	112	0	0	112
Harvest & hauling	703	27	721	25	52
Other production	375	15	377	13	28
Total production	5665	219	1098	38	257
Other farm use	440	17	496	17	34
Transportation	0	0	6422	222	222
Total farm use	6105	236	8016	277	513
Non-farm use	0	0	34	1	1
Total	6105	236	8050	278	514

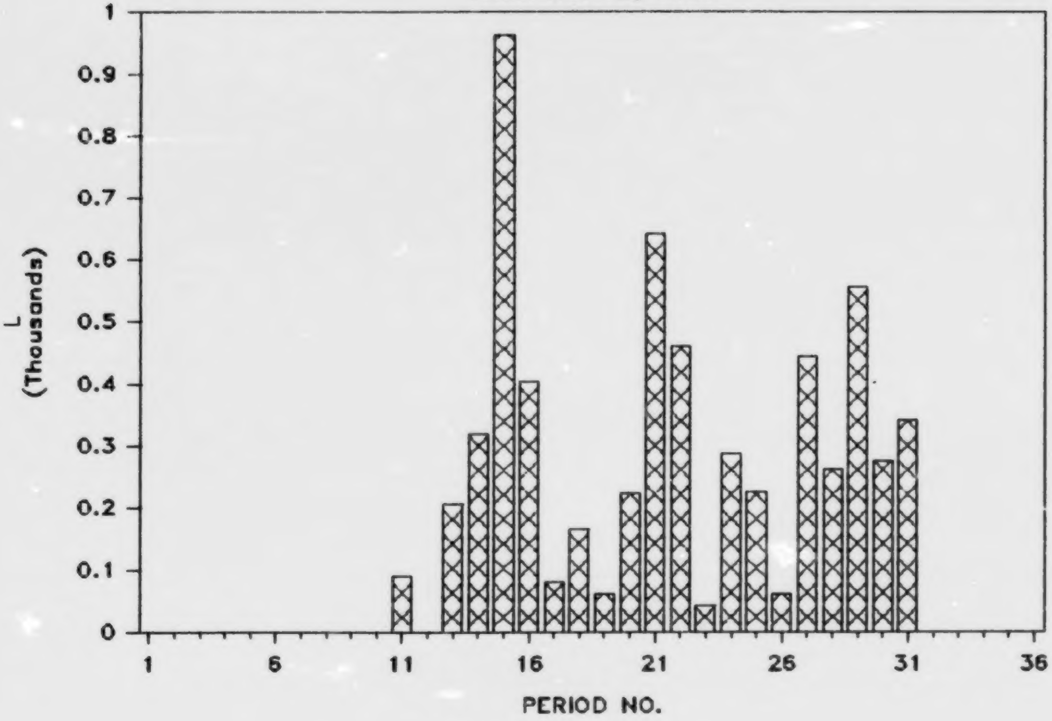
LIQUID FUEL USE BY OPERATION, 1983

FARM NO.12



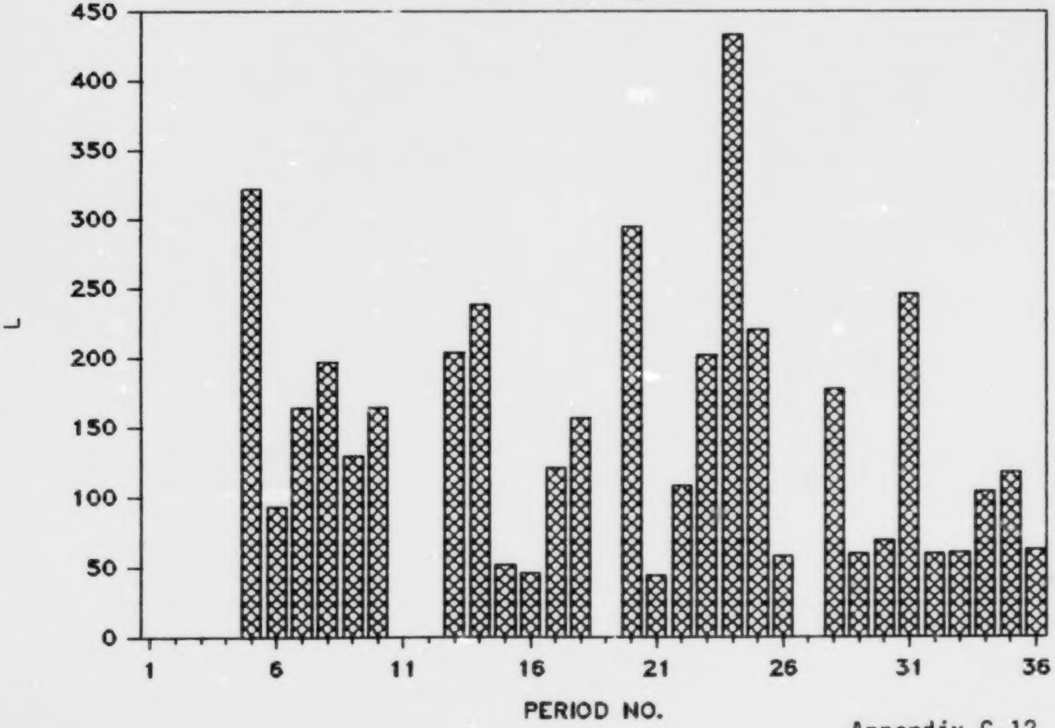
USE OF DIESEL FUEL BY 10–DAY PERIOD

FARM NO. 12, 1983



USE OF GASOLINE BY 10–DAY PERIOD

FARM NO. 12, 1983

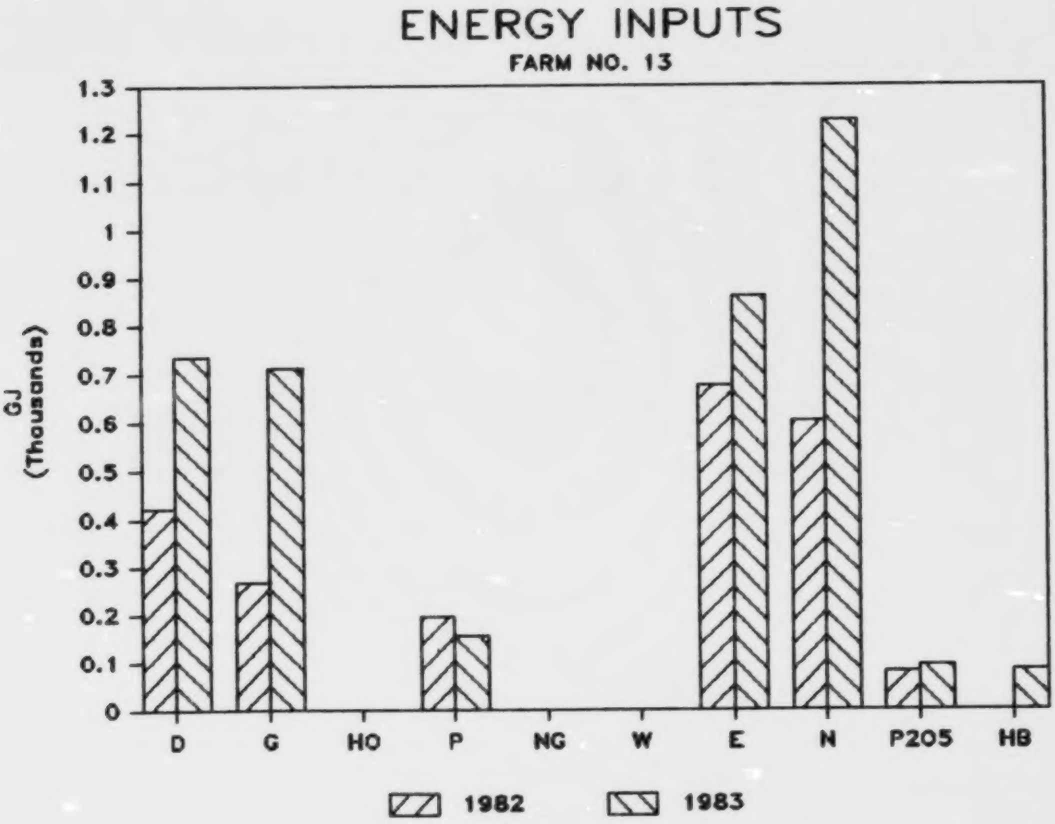


FARM #13
Name: Larson
Location: Semans
Farm Type: Grain and Hay, Hogs
Cultivated Area (ha): 535
Soil Zone: Dk. Brown

ENERGY INPUTS FARM NO. 13

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	10911	19016	422	736
Gasoline	G	L	7748	20641	267	712
Heating Oil	HO	L	0	0	0	0
Propane	P	L	7595	6050	194	155
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	187980	239220	677	861
Nitrogen	N	kg N	8033	16573	602	1226
Phosphorus	P205	kg P205	7331	8448	81	93
Herbicides	HB	kg AI	NR	385	NR	83

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- metered volumes of diesel fuel and gasoline shown for 1982 are suspect
- NR = not recorded



FARM NO. 13 - CROP PRODUCTION PRACTICES -1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL		FERTILIZER TYPE	RATE (lb/ac)	HERBICIDES TYPE	RATE (oz/ac)	YIELD (bu/ac)	REMARKS
					D	G						
Spring wheat	122		Cult (HD)	2X	✓		27-27-0	150	Banvil		31	
			Harrow	1X	✓				2,4-D			
			Press Drill	1X	✓							
			Spray	1X		✓						
			Swath	1X	✓							
			Combine	1X	✓							
			Truck			✓						
Spring wheat	217		Cult (HD)	2X			11-51-0	67	Banvil		33	
			Harrow	1X					2,4-D			
			Press Drill	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Truck									
Rape	73		Cult (HD)	1X			11-51-0	50	Treflan		30	
			Cult HD	2X								
			Harrow	1X								
			Press Drill	1X								
			Swath	1X								
			Combine	1X								
			Truck									
Barley		55	Band fertilizer	1X			46-0-0	130	Banvil		38	
			Air seeder	1X			11-51-0	67	2,4-D			
			Spray	1X								
			Harrow	1X								
			Swath	1X								
			Combine	1X								
			Truck									
Barley		350	Band fertilizer	1X			46-0-0	130	Banvil		40	
			Cult (HD)	1X					2,4-D			
			Discer	1X								
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Truck									
Barley		74	Band fertilizer	1X			46-0-0	130	Banvil		65	
			Cult HD	1X			11-51-0	67	2,4-D			
			Press Drill	1X								
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Fallow			Cult (HD)	5X								

N.B. Straw baling not included.

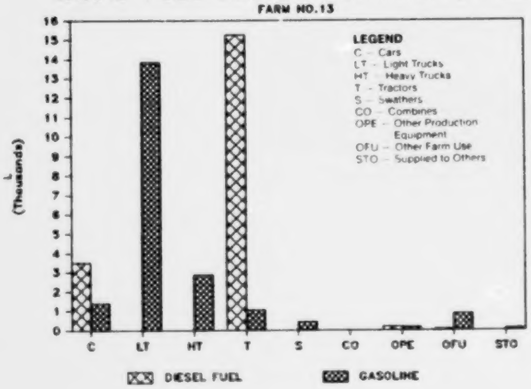
LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 13

	Total Fuel Use	-------Fuel Use Rate---------				
EQUIPMENT	L	L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Car, Pontiac, 1981	3510			8.7	11.5	32
Crawler, JD 1010, 1961	136					
Generator set	40					
Non-energy use	76					
Tractor (borrowed)	1150					
Tractor, IHC 806 (borrowed)	100					
Tractor, JD 4020, 1965	2074	6.3	1.4			
Tractor, JD 4320, 1972	4362	7.5	1.7			
Tractor, JD 4640, 1978	7568	17.3	3.8			
Total	19016					
Gasoline						
Auger	103					
Car, Chevelle, 1969	1372			27.1	3.7	10
Garden tractor, JD 318	218					
Lawnmower	75					
Non-energy use	6					
Pump	9					
Rototiller	45					
Supplied to others	79					
Swather, MF 655, 1976	429					
Tractor, Ford 9N, 1945	200					
Tractor, IHC Farmall M, 1952	844					
Tricycle, Honda	391					
Truck, 1 ton, GMC, 1952	364					
Truck, 1 ton, GMC, 1966	411			43.2	2.3	7
Truck, 1/2 ton, Chev, 1976	5436			20.9	4.8	13
Truck, 1/2 ton, Chev, 1978	7154			21.1	4.7	13
Truck, 3 ton, IHC, 1970	2083			65.6	1.5	4
Truck, Mazda 1600, 1971	1244			15.2	6.6	19
Uniloader (rented)	55					
Welder	123					
Total	20641					

LIQUID FUEL USE BY EQUIPMENT, 1983

FARM NO.13



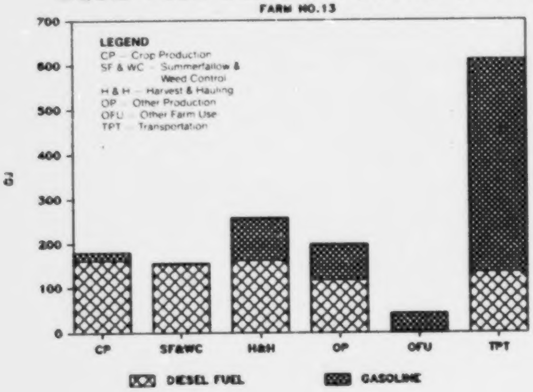
LIQUID FUEL USE BY OPERATION, 1983

Farm No. 13

	Diesel Fuel		Gasoline		Total
OPERATION	L	GJ	L	GJ	GJ
Crop production	4194	162	505	17	180
Summerfallow & weed control	3961	153	70	2	156
Harvest & hauling	4184	162	2782	96	258
Other production	3052	118	2321	80	198
Total production	15391	596	5678	196	792
Other farm use	115	4	1100	38	42
Transportation	3510	136	13798	476	612
Total farm use	19016	736	20576	710	1446
Non-farm use	0	0	65	2	2
Total	19016	736	20641	712	1448

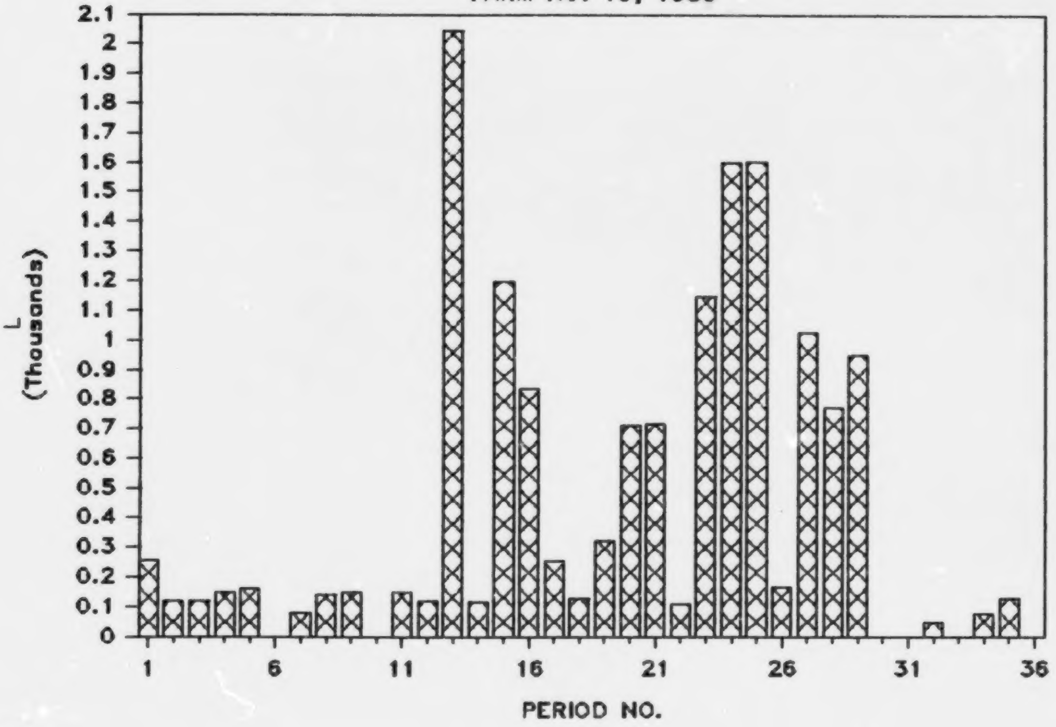
LIQUID FUEL USE BY OPERATION, 1983

FARM NO.13



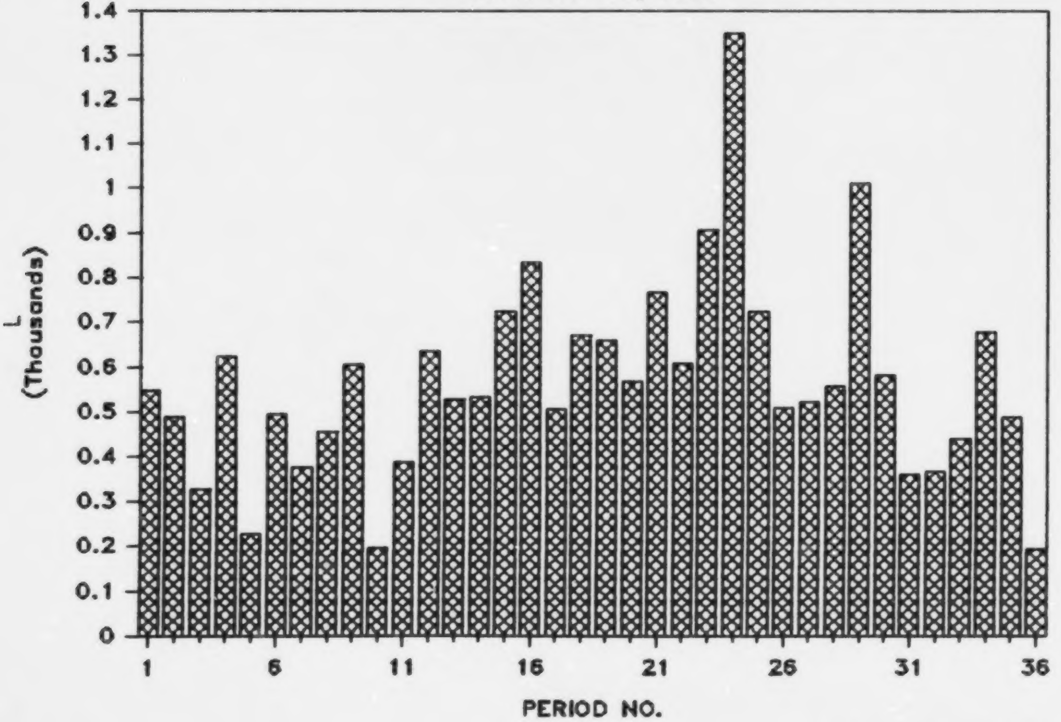
USE OF DIESEL FUEL BY 10-DAY PERIOD

FARM NO. 13, 1983



USE OF GASOLINE BY 10-DAY PERIOD

FARM NO. 13, 1983

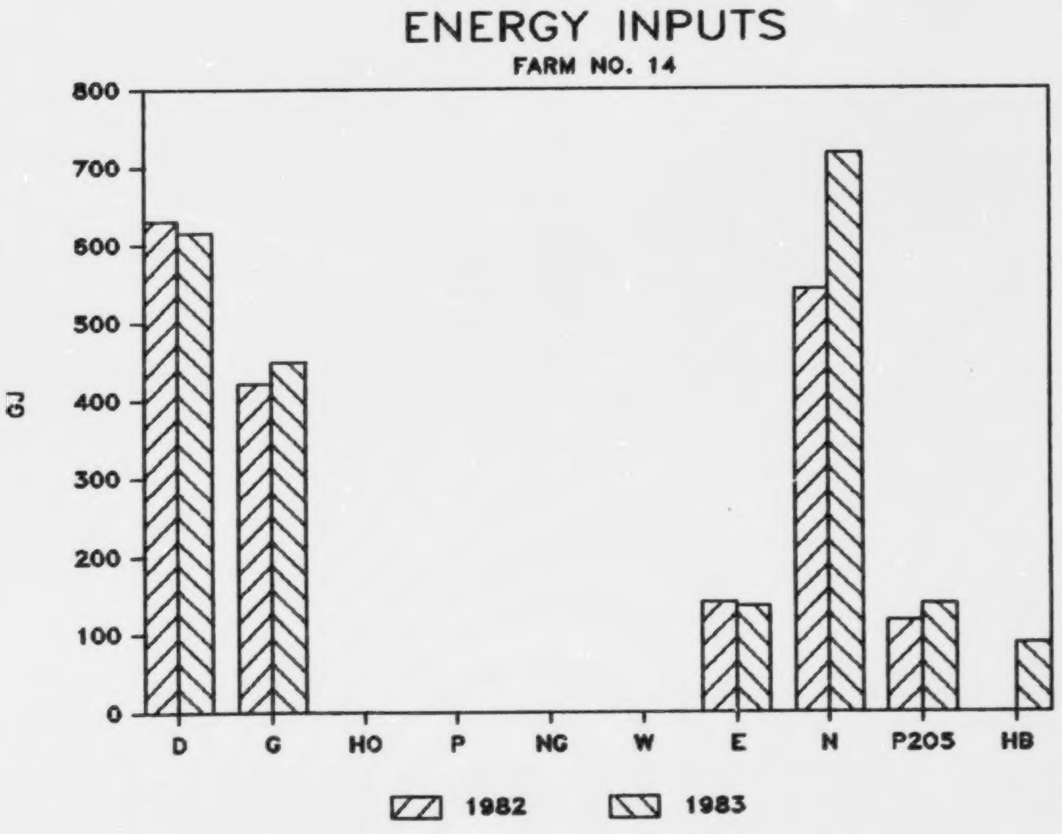


FARM #14
Name: Robb
Location: Mossbank
Farm Type: Grain
Cultivated Area (ha): 820
Soil Zone: Brown

ENERGY INPUTS FARM NO. 14

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	16277	15908	630	616
Gasoline	G	L	12239	13047	422	450
Heating Oil	HO	L	0	0	0	0
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	38850	37460	140	135
Nitrogen	N	kg N	7989	11035	543	717
Phosphorus	P205	kg P205	10588	12536	116	138
Herbicides	HB	kg AI	NR	461	NR	88

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded



FARM NO. 14 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL C	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring wheat		250	Harrow	1X	✓		82-0-0		Avadex on 85 acres		30	
			Deep banding	1X	✓		11-53-0	42	Matavan on 40 acres			
			Discer	1X	✓				Hoegrass on 35 acres			
			Cult (HD)	1X	✓				2,4-D-128			
			Harrow	1X	✓							
			Spray	1X	✓							
			Swath	1X	✓							
			Combine	1X	✓							
			Trucking			✓						
Spring wheat		600	Rodweed				11-53-0	40	Avadex on 100 acres		30	
			Cult (HD)						Buctril on 280 acres			
			Discer						2,4-D 128 on 320 acres			
			Spray									
			Harrow									
			Spray									
			Swath									
			Combine									
			Trucking									
Durum		375	Cult (HD)				82-0-0				30	
			Deep banding				11-51-0	42	Avadex on 40 acres			
			Harrow						Hoegrass on 35 acres			
			Discer						2,4-D 128			
			Harrow									
			Spray									
			Swath									
			Combine									
			Trucking									
Barley		50	Cult (HD)				46-0-0	100	2,4-D 128		42	
			Spread fertilizer									
			Discer									
			Harrow									
			Spray									
			Swath									
			Combine									
			Trucking									
Fallow	395		Cult (HD)	3X								
	100		Cult (HD)	4X								
	55		Spray	1X					Heritage			
	55		Cult (HD)	3X								
	200		Cult (HD)	2X								
	200		Rodweed	1X								

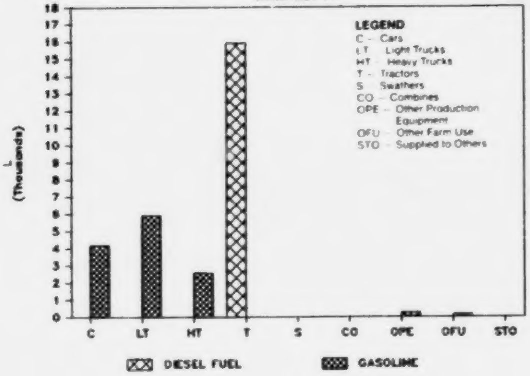
LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 14

	Total	-------Fuel Use Rate---------				
	Fuel Use					
EQUIPMENT	L	L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Tractor, JD 2130, 1977	197	5.7	1.3			
Tractor, JD 4440, 1979	4201	14.6	3.2			
Tractor, JD 4640, 1982	11510	22.4	4.9			
Total	15908					
Gasoline						
Auger	229					
Car, Mercury Marquis, 1975	1700			22.0	4.5	13
Car, Oldsmobile, 1982	2500			11.3	8.8	25
Garden tractor	105					
Pump	4					
Snowmobiles	22					
Tractor, MH 50, 1953	15	1.9	0.4			
Truck, 1/2 ton, Chev, 1982	3651			13.8	7.2	20
Truck, 1/2 ton, S15, 1982	2262			9.9	10.1	29
Truck, 2 ton, Chevrolet, 1976	231			25.0	4.0	11
Truck, 3 ton, Chev, 1976	2328			43.1	2.3	7
Total	13047					

LIQUID FUEL USE BY EQUIPMENT, 1983

FARM NO. 14



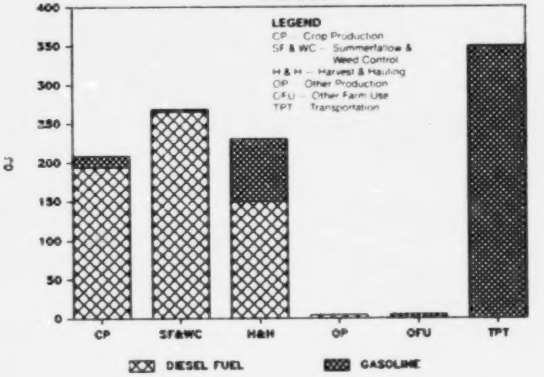
LIQUID FUEL USE BY OPERATION, 1983

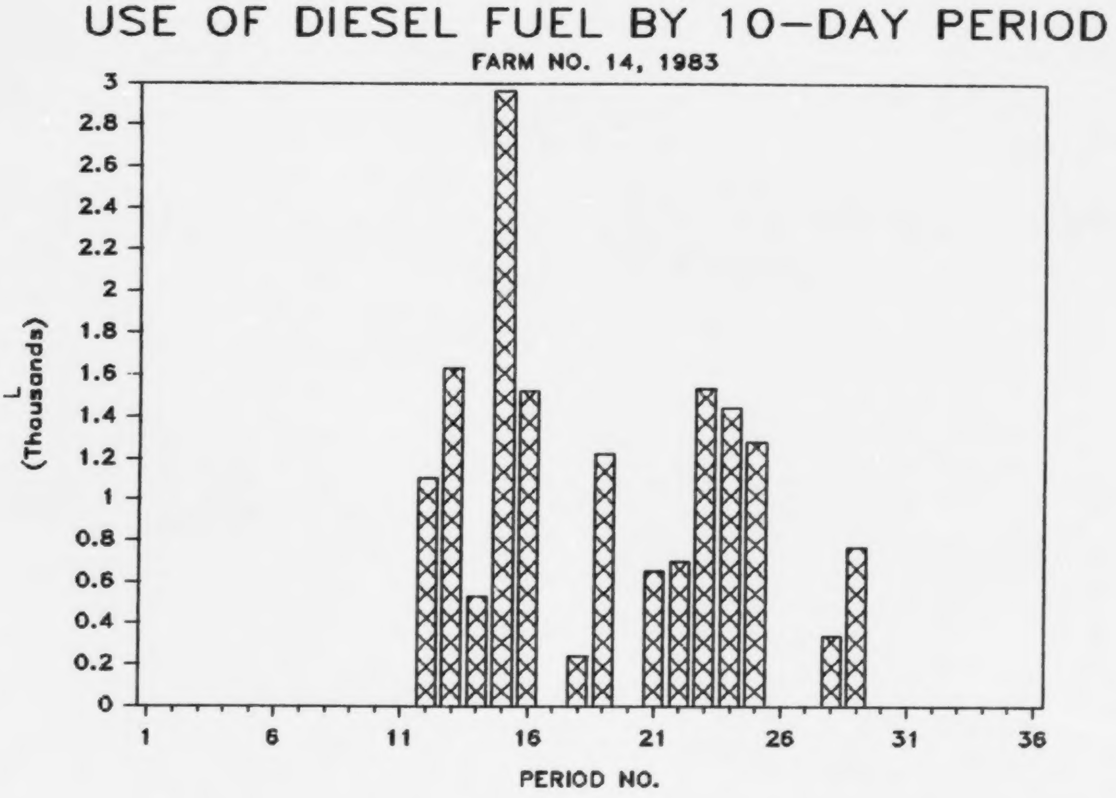
Farm No. 14

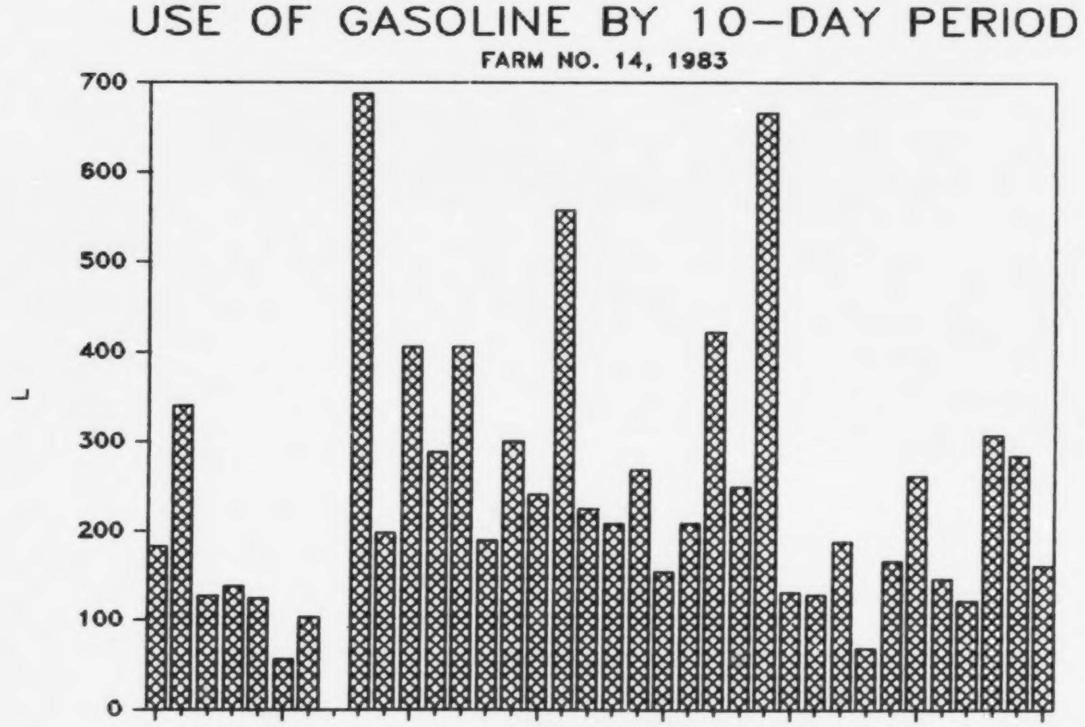
	Diesel Fuel		Gasoline		Total
OPERATION	L	GJ	L	GJ	GJ
Crop production	5045	195	390	13	209
Summerfallow & weed control	6857	265	94	3	269
Harvest & hauling	3898	151	2308	80	230
Other production	108	4	0	0	4
Total production	15908	616	2792	96	712
Other farm use	0	0	142	5	5
Transportation	0	0	10113	349	349
Total farm use	15908	616	13047	450	1066
Non-farm use	0	0	0	0	0
Total	15908	616	13047	450	1066

LIQUID FUEL USE BY OPERATION, 1983

FARM NO.14




USE OF DIESEL FUEL BY 10–DAY PERIOD
FARM NO. 14, 1983
L
(Thousands)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
1
6
11
16
21
26
31
36
PERIOD NO.


USE OF GASOLINE BY 10–DAY PERIOD
FARM NO. 14, 1983
L
0
100
200
300
400
500
600
700
1
6
11
16
21
26
31
36
PERIOD NO.

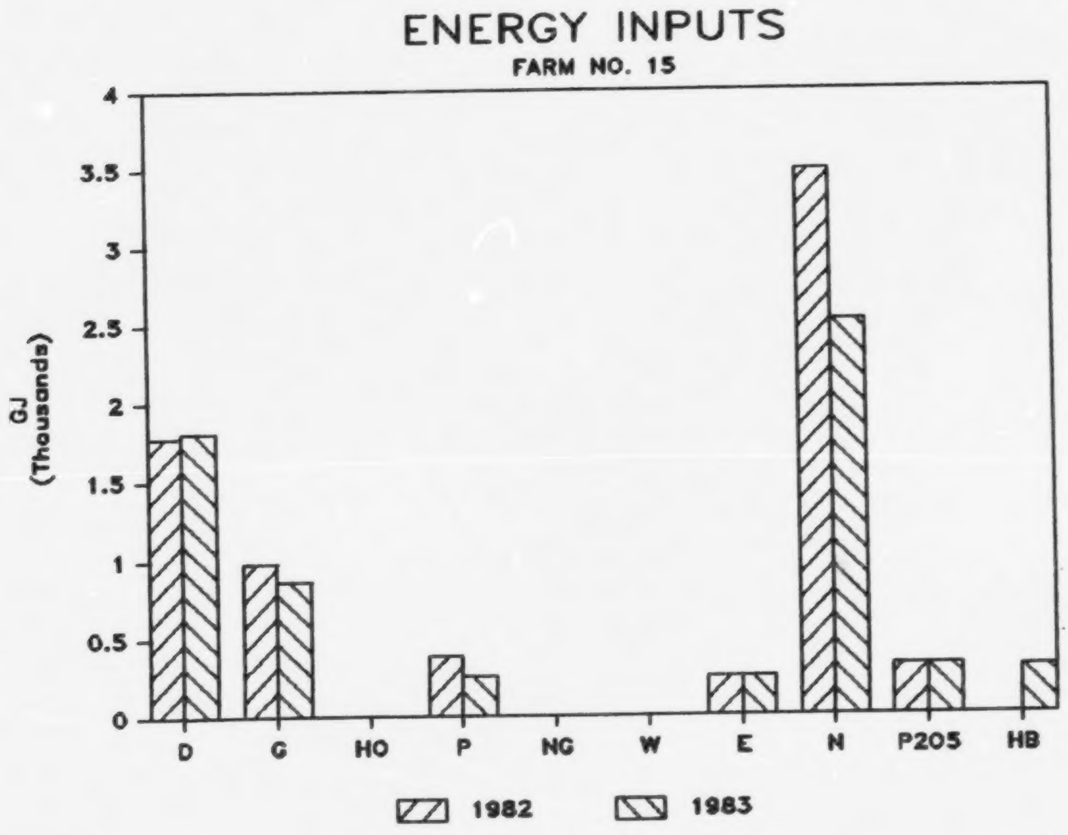
FARM #15
Name: Slimmon
Location: Heward
Farm Type: Grain
Cultivated Area (ha): 1730
Soil Zone: Dk. Brown

ENERGY INPUTS FARM NO. 15

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	45955	46821	1778	1812
Gasoline #	G	L	28235	25006	974	863
Heating Oil	HO	L	0	0	0	0
Propane	P	L	14891	9939	381	254
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	68653	67167	247	242
Nitrogen	N	kg N	47110	40545	3486	2514
Phosphorus	P205	kg P205	29046	29098	320	320
Herbicides	HB	kg AI	NR	974	NR	302

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

# includes aviation gasoline: 1981 - 2758 L; 1982 - 4041 L; 1983 - 4487 L



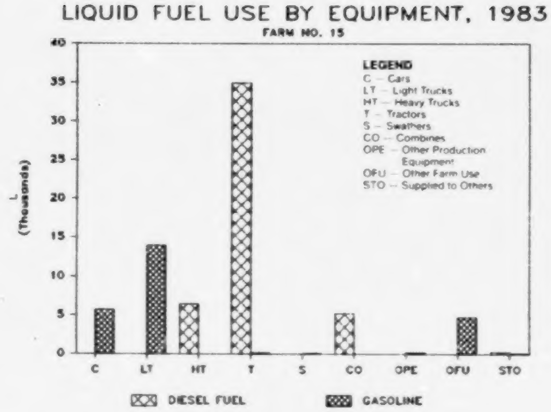
, FARM NO. 15 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring wheat	460		Discers	1X	✓		P_2O_5	20	Estamine Banvil		21.1	
			Harrow Pack	2X	✓							
			Air Spray	1X	✓							
			Combine	1X	✓							
			Trucking									
Durum	215		Discers	1X			P_2O_5	20	Estamine Banvil		22.8	
			Harrow Pack	2X								
			Air Spray	1X								
			Combine	1X								
			Trucking									
Spring wheat		645	Deep band	1X			P_2O_5	21	Estamine Banvil		20.0	
			Discer	1.5X			N	428				
			Harrow Pack	1X								
			Air Spray	1X								
			Combine	1X								
			Trucking									
Durum		295	Deep Band	1X			P_2O_5	20	Estamine Banvil		24	
			Discer	1X			N	62.5				
			Harrow Pack	1X								
			Air Spray	1X								
			Combine	1X								
			Trucking									
Barley	90		Discers	1X			P_2O_5	20	Estamine Banvil		13.8	
			Harrow Pack	1X								
			Air Spray	1X								
			Combine	1X								
			Trucking									
Barley		455	Deep Band	1X			P_2O_5	20	Estamine Banvil		13.8	
			Discer	1X			N	50				
			Harrow & Pack	1X								
			Air Spray	1X								
			Combine	1X								
			Trucking									
Rape	965		Cult HD	1.5X			P_2O_5	20	Treflan		5.65	
			Rodweed & Harrow	1X			N	0.10				
			Press Drill	1X								
			Swath	1X								
			Combine	1X								
			Trucking	1X								
Fallow	1149		Cult (HD)	1X								
			Cult (LD)	3X								

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 15

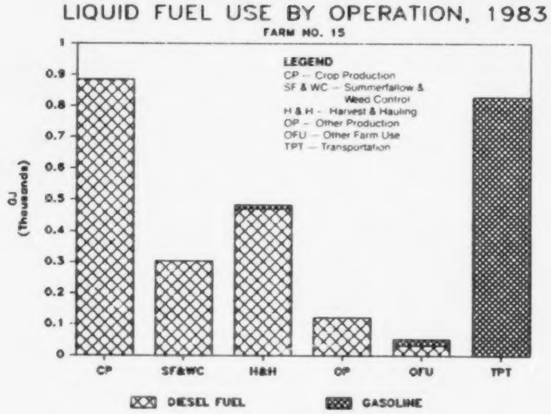
EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Combine, MF 760, 1973	2643					
Combine, MF 760, 1978	2544					
Non-energy use	22					
Supplied to others	229					
Tractor, Case 830, 1964	222					
Tractor, JD 4430, 1976	4402	11.3	2.5			
Tractor, Vers 145, 1970	7049	24.1	5.3			
Tractor, Vers 850, 1975	23256	39.3	8.7			
Truck, tandem, Ford, 1971	6454			58.9	1.7	5
Total	46821					
Gasoline						
Airplane	4487					
Auger	132					
Boat	170					
Car, Mercury, 1978	3650			16.6	6.0	17
Car, Mercury, 1980	2050			12.8	7.8	22
Garden tractor	13					
Lawnmower	32					
Non-energy use	68					
Pump	46					
Supplied to others	60					
Swather, CCIL, 1974	123					
Tractor, Massey 50, 1960	168					
Truck, 1/2 ton, Ford, 1983	1589			24.0	4.2	12
Truck, 3/4 ton, Ford, 1973	1002			25.2	4.0	11
Truck, 3/4 ton, Ford, 1974	2692			26.3	3.8	11
Truck, Ford 250, 1983	5660			17.6	5.7	16
Truck, Ford Ranger, 1983	3050			11.3	8.8	25
Welder	14					
Total	25006					



LIQUID FUEL USE BY OPERATION, 1983

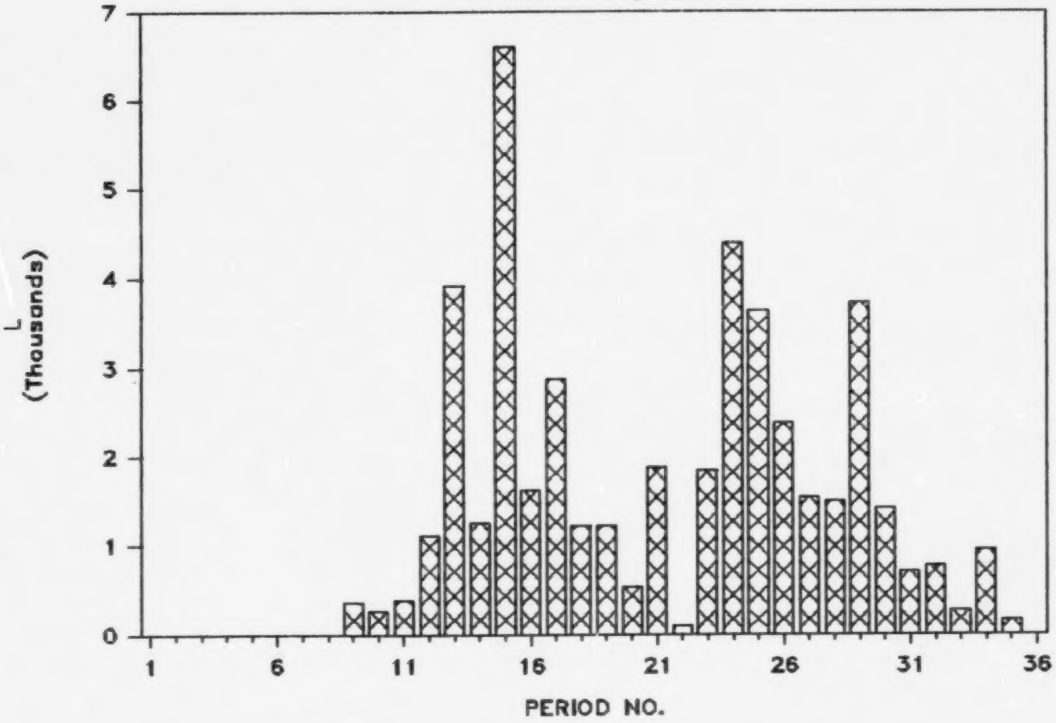
Farm No. 15

OPERATION	Diesel Fuel L	GJ	Gasoline L	GJ	Total GJ
Crop production	22833	884	37	1	885
Summerfallow & weed control	7817	303	0	0	303
Harvest & hauling	12177	471	374	13	484
Other production	3138	121	0	0	121
Total production	45965	1779	411	14	1793
Other farm use	856	33	571	20	53
Transportation	0	0	24001	828	828
Total farm use	46821	1812	24983	862	2674
Non-farm use	0	0	23	1	1
Total	46821	1812	25006	863	2675



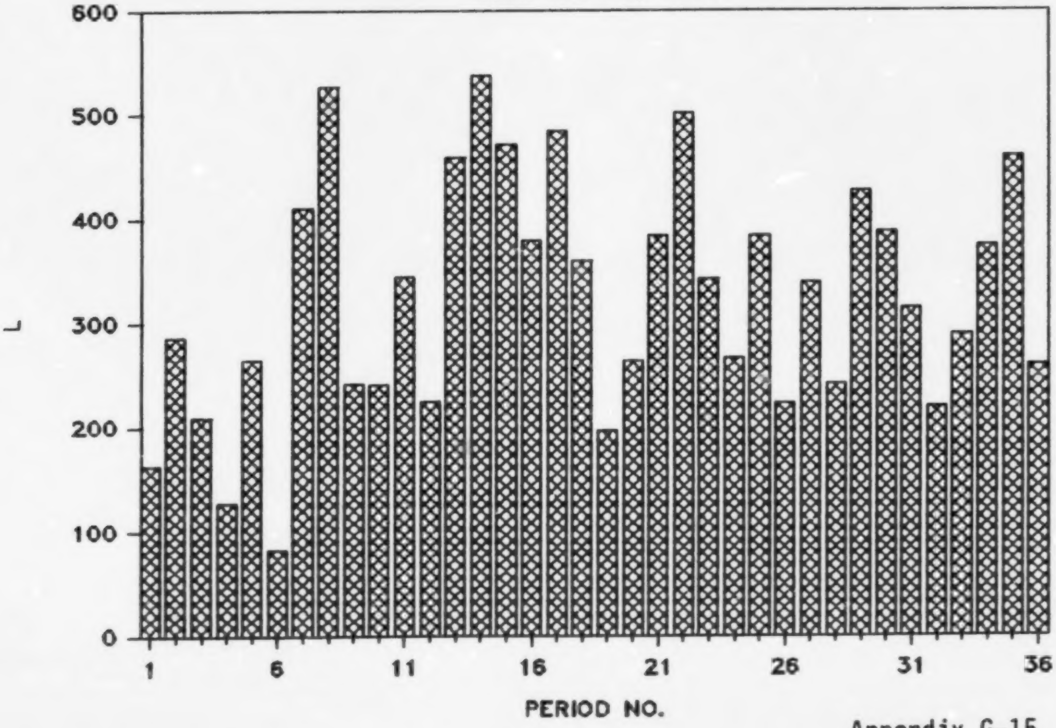
USE OF DIESEL FUEL BY 10–DAY PERIOD

FARM NO. 15, 1983



USE OF GASOLINE BY 10–DAY PERIOD

FARM NO. 15, 1983

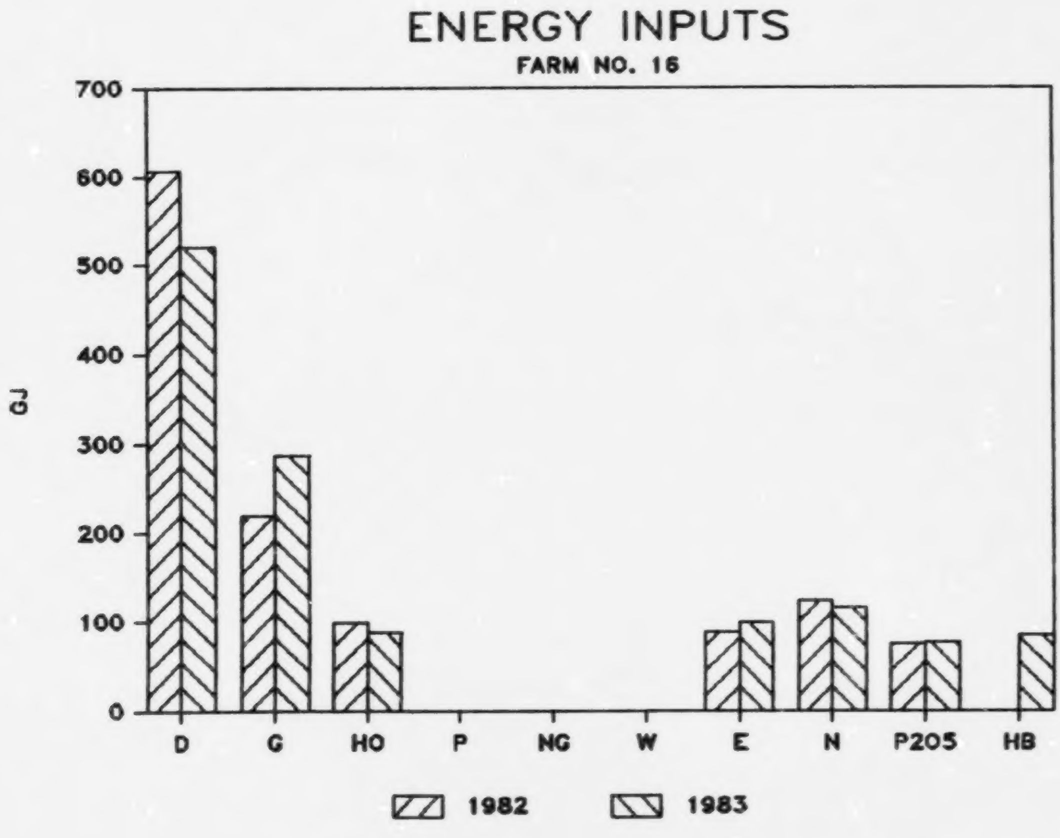


ENERGY INPUTS FARM NO. 16

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	15687	13461	607	521
Gasoline	G	L	6339	8295	219	286
Heating Oil	HO	L	2579	2306	100	89
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	24475	27736	88	100
Nitrogen	N	kg N	1489	1388	124	115
Phosphorus	P205	kg P205	6903	6942	76	76
Herbicides	HB	kg AI	NR	337	NR	84

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

FARM #16
Name: Reynolds
Location: Kerrobert
Farm Type: Grain
Cultivated Area (ha): 628
Soil Zone: Brown



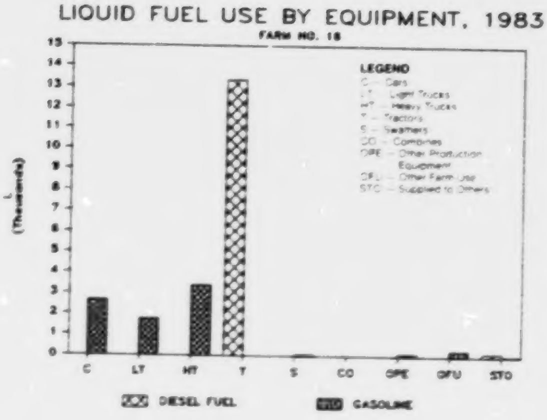
FARM NO. 16 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring wheat	443		Cult (HD)	3X	x		11-55-0	35	Avadex		33	
			Hoedrill	1X	x				Buctril M on 126 acres			
			Spray	1X	x				Glean on 20 acres			
			Swath	1X	x							
			Combine	1X	x							
			Trucking			x						
Barley	312		Cult (HD)				11-55-0	35	Avadex		59	
			Hoedrill						Buctril M on 78 acres			
			Spray									
			Swath									
			Combine									
			Trucking									
Lentils		40	Harrow				11-55-0	35	Hoegrass			
			Cult (HD)						SENCOR on 40 acres			
			Discer									
			Harrow pack									
			Swath									
			Combine									
			Trucking									
Fallow	756		Cult HD	3X								
	676		Cult LD	1X								
	80		Cult LD	1x								

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 16

EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Supplied to others	149					
Tractor, Case 4490, 1981	10049	22.5	5.0			
Tractor, JD 4020, 1970	695	7.6	1.7			
Tractor, JD 4430, 1976	2568	13.1	2.9			
Total	13461					
Gasoline						
Auger	125					
Car, Citation, 1980	2649			11.8	8.5	24
Garden tractor	152					
Non-energy use	68					
Snowmobile	29					
Supplied to others	35					
Swather, IHC 175, 1970	69					
Truck, 1/2 ton, Chev, 1966	352			20.8	4.8	14
Truck, 2.5 ton, GMC, 1956	850			42.7	2.3	7
Truck, 3 ton, GMC, 1975	2545			41.1	2.4	7
Truck, Ford F150, 1975	1421			18.7	5.3	15
Total	8295					

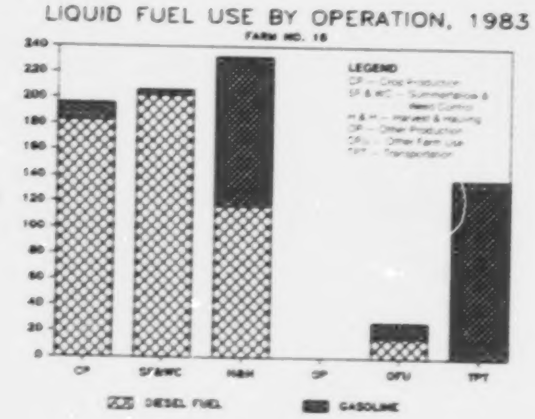

LIQUID FUEL USE BY EQUIPMENT, 1983

FARM NO. 16

LIQUID FUEL USE BY OPERATION, 1983

Farm No. 16

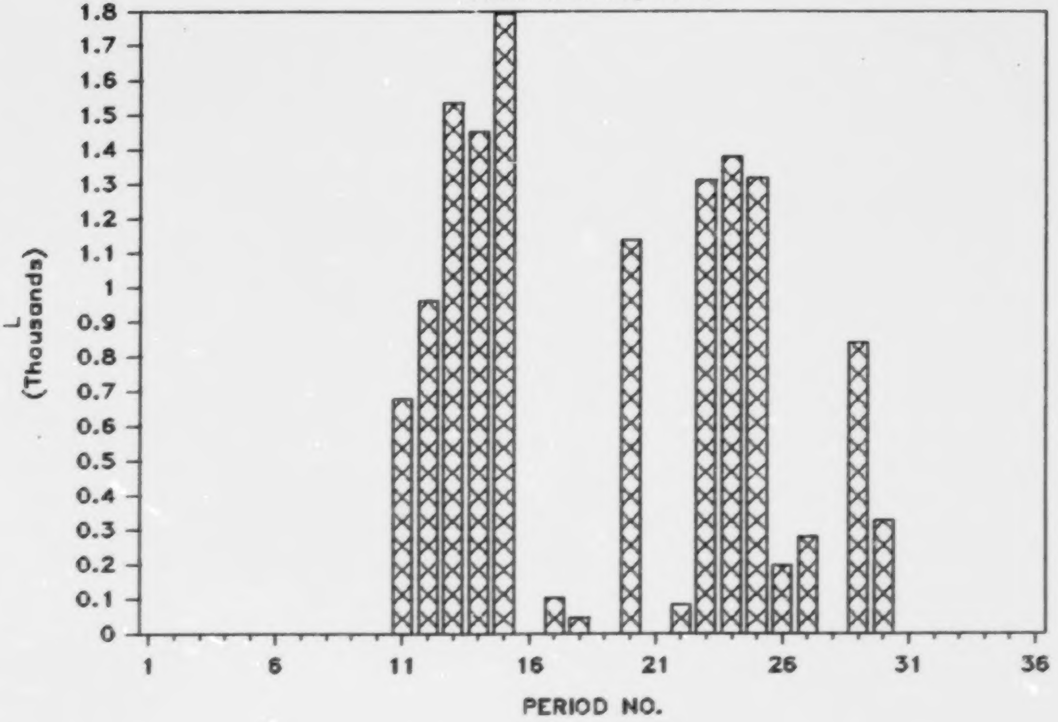
OPERATION	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Crop production	4721	183	393	14	196
Summerfallow & weed control	5225	202	112	4	206
Harvest & hauling	3009	116	3340	115	232
Other production	0	0	0	0	0
Total production	12955	501	3845	133	634
Other farm use	412	16	324	11	27
Transportation	0	0	3995	138	138
Total farm use	13367	517	8164	282	799
Non-farm use	94	4	131	5	8
Total	13461	521	8295	286	807


LIQUID FUEL USE BY OPERATION, 1983

FARM NO. 16

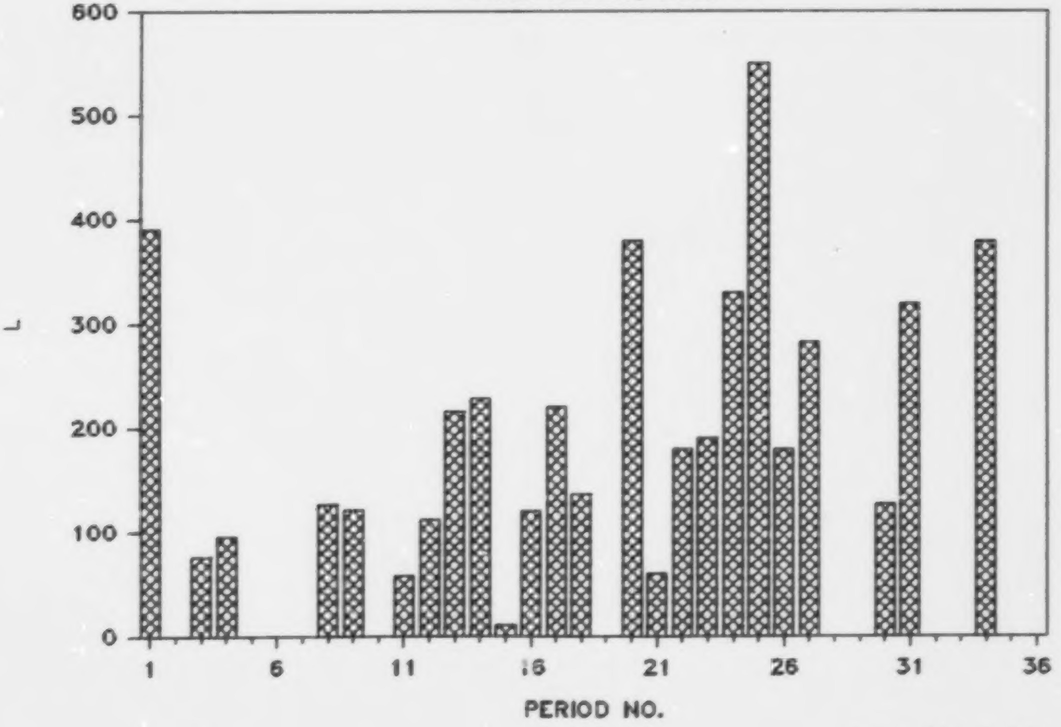
USE OF DIESEL FUEL BY 10-DAY PERIOD

FARM NO. 16, 1983



USE OF GASOLINE BY 10-DAY PERIOD

FARM NO. 16, 1983

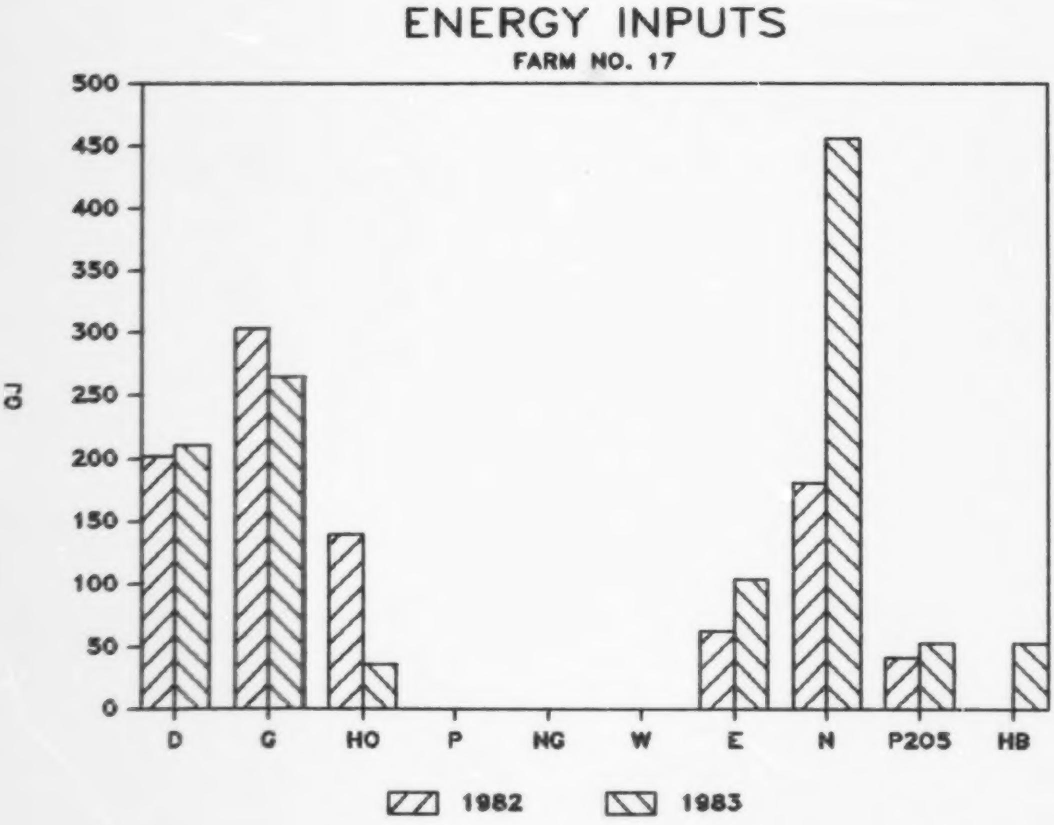


FARM #17
Name: Connick
Location: Gull Lake
Farm Type: Grain and Silage, Beef
Cultivated Area (ha): 345
Soil Zone: Dk. Brown

ENERGY INPUTS FARM NO. 17

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	5201	5438	201	210
Gasoline	G	L	8797	7669	303	265
Heating Oil	HO	L	3611	919	140	36
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	17230	28840	62	104
Nitrogen	N	kg N	2345	6079	181	456
Phosphorus	P205	kg P205	3789	4790	42	53
Herbicides	HB	kg AI	NR	149	NR	53

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded



FARM NO 17 - CROP PRODUCTION PRACTICES - 1983

Sheet 1 Of 2

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS		FUEL		FERTILIZER		HERBICIDES		YIELD (bu/ac)	REMARKS
			MACHINE	NO.	D	G	TYPE	RATE (lb/ac)	TYPE	RATE (oz/ac)		
Spring wheat	80		Discer	1X	✓		11-48-0	40	Hoegrass		27	
			Harrow	1X	✓				Pardner			
			Spray	1X	✓							
			Swath	1X	✓							
			Combine	1X		✓						
			Trucking									
Spring wheat	40		Discer	1X			11-48-0	40	Buctril M		27	
			Harrow	2X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Spring wheat		40	Spread fertilizer	1X			34-0-0	170	Hoegrass		40	
			Discer	1X			11-48-0	40	Pardner			
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Spring wheat		110	Spread fertilizer				34-0-0	170			30	
			Discer				11-48-0	40				
			Harrow									
			Swath									
			Combine									
			Trucking									
Spring wheat		40	Band fertilizer	1X			34-0-0	170	Hoegrass		30	
			Discer	1X			11-48-0	40	Pardner			
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine									
			Trucking									
Spring wheat	60		Discer	1X			11-48-0	40			30	
			Harrow	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Spring wheat	40		Discer	1X			11-48-0	48	Hoegrass		25	
			Rodweed	1X					Buctril M			
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Spring wheat	40		Discer	1X			11-48-0	40	Glean		25	
			Rodweed	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley	40		Discer	1X			11-48-0	50	Glean		50	
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									

FARM NO. 17 - CROP PRODUCTION PRACTICES - 1983

Sheet 2 of 2

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Barley	40		Discer	1X			11-48-0	50			30	
			Harrow	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Fallow	280		Cult (HD)	2X								
			Rodweed	1								
Fallow	40		Cult	1X								
			Rodweed	1X								
Chem Fallow	40		Spray	4X					Roundup Banvel			
									2,4-D 500 Banvel			
									Sweep Banvel			
									Sweep			

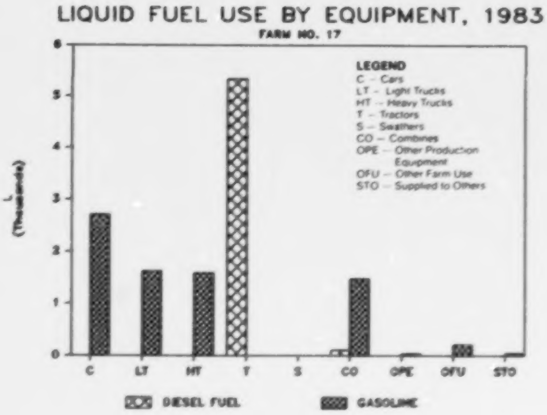
N.B. Straw baling not included.

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 17

EQUIPMENT	Total Fuel Use L	L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Combine (demo)	100	14.3				
Tractor, IHC 1086, 1979	4444	12.5	2.8			
Tractor, IHC 624, 1966	894	4.2	0.9			
Total	5438					
Gasoline						
Auger	30					
Car, Cordoba, 1979	2711			12.9	7.8	22
Combine, IHC 715, 1975	1471					
Lawnmower	162					
Non-energy use	45					
Supplied to others	45					
Truck, 1/2 ton, F100, 1979	1617			16.6	6.0	17
Truck, 3 ton, Ford 600, 1979	1438			40.2	2.5	7
Truck, Ford, 1970	150			43.2	2.3	7
Total	7669					

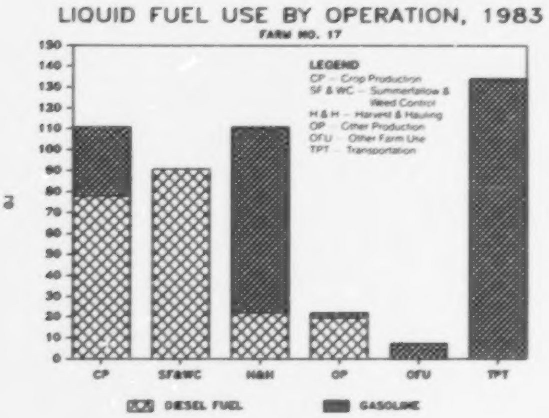
(Fuel Use Rate: L/h, gph, L/100 km, km/L, mpg)



LIQUID FUEL USE BY OPERATION, 1983

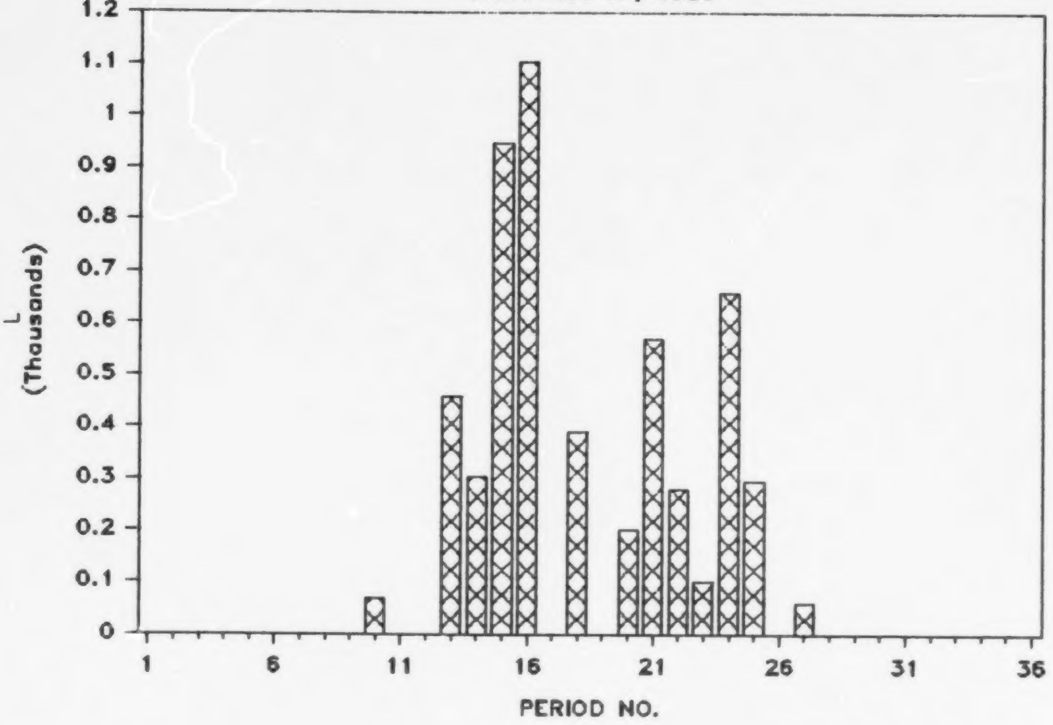
Farm No. 17

OPERATION	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Crop production	2011	78	951	33	111
Summerfallow & weed control	2342	91	0	0	91
Harvest & hauling	575	22	2565	88	111
Other production	510	20	60	2	22
Total production	5438	210	3576	123	334
Other farm use	0	0	207	7	7
Transportation	0	0	3886	134	134
Total farm use	5438	210	7669	265	475
Non-farm use	0	0	0	0	0
Total	5438	210	7669	265	475



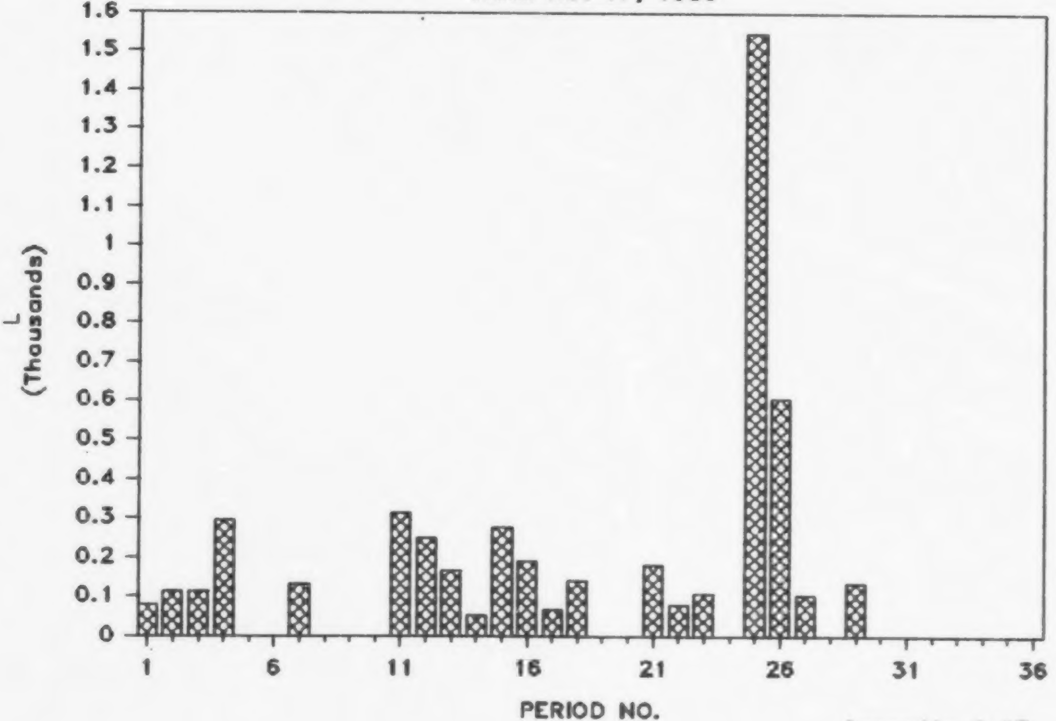
USE OF DIESEL FUEL BY 10–DAY PERIOD

FARM NO. 17, 1983



USE OF GASOLINE BY 10–DAY PERIOD

FARM NO. 17, 1983

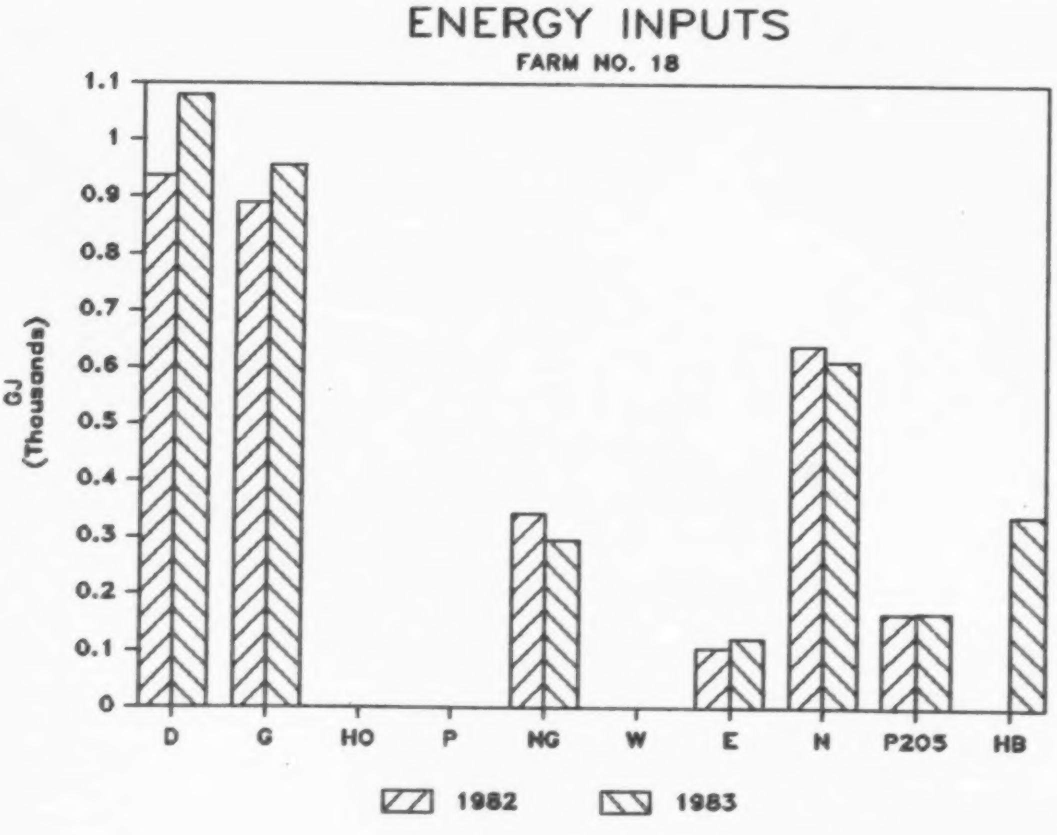


ENERGY INPUTS FARM NO. 18

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	24229	27847	938	1078
Gasoline	G	L	25814	27680	891	955
Heating Oil	HO	L	0	0	0	0
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	9222	7963	343	296
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	29290	33890	105	122
Nitrogen	N	kg N	8303	9131	639	612
Phosphorus	P205	kg P205	15249	15416	168	170
Herbicides	HB	kg AI	NR	1369	NR	339

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

FARM #18
Name: Hanney
Location: McGee
Farm Type: Grain
Cultivated Area (ha): 1246
Soil Zone: Brown



FARM NO. 18 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring wheat		200	Deep banding	1X	✓		82-0-0	64	Avadex		36.7	
			Discer	1X	✓		11-51-0	40	Buctril M			
			Harrow pack	1X	✓							
			Spray	1X	✓							
			Swath	1X	✓							
			Combine		✓							
			Trucking			✓						
Spring wheat	1286		Rodweed				11-51-0	40	Avadex		39.5	
			Discer						Buctril M			
			Harrow Pack									
			Spray									
			Swath									
			Combine									
			Trucking									
Barley	80		Rodweed				11-51-0	40	Avadex		80	
			Discer						Buctril M			
			Harrow Pack									
			Spray									
			Swath									
			Combine									
			Trucking									
Flax	60		Rodweed				11-51-0	40	Avadex		20.5	
			Discer									
			Harrow Pack									
			Spray									
			Swath									
			Combine									
			Trucking									
Lentils	40		Rodweed				11-51-0	40	Avadex		32.3	
			Discer									
			Harrow Pack									
			Spray									
			Swath									
			Combine									
			Trucking									
Fallow	1414		Cult (MD)									
			Rodweed (MD)									

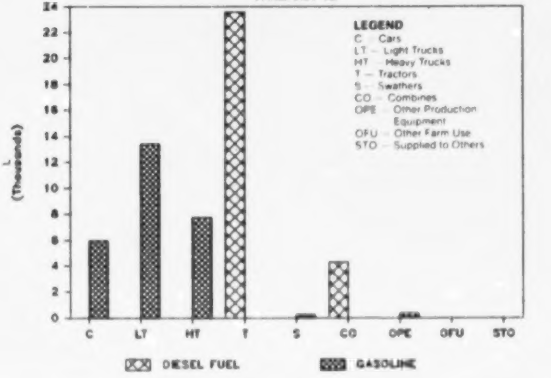
LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 18

EQUIPMENT	Total Fuel Use L	L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Combine, MF 750, 1979	4288					
Tractor, Case 1175, 1978	6005					
Tractor, JD 4020, 1977	721					
Tractor, JD 8450, 1983	16833					
Total	27847					
Gasoline						
Augers (2)	339					
Car, Oldsmobile, 1981	5961			10.0	10.0	28
Swather	242					
Truck, 1/2 ton, Chev, 1975	5590			24.9	4.0	11
Truck, 1/2 ton, Chev, 1978	7810			22.8	4.4	12
Truck, 3 ton, GMC, 1974	2069			25.9	3.9	11
Truck, 3 ton, GMC, 1981	5669			38.0	2.6	7
Total	27680					

LIQUID FUEL USE BY EQUIPMENT, 1983

FARM NO. 18



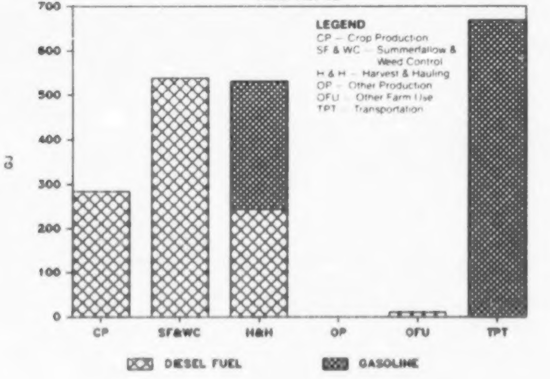
LIQUID FUEL USE BY OPERATION, 1983

Farm No. 18

OPERATION	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Crop production	7316	283	0	0	283
Summerfallow & weed control	13910	538	0	0	538
Harvest & hauling	6325	245	8319	287	532
Other production	0	0	0	0	0
Total production	27551	1066	8319	287	1353
Other farm use	296	11	0	0	11
Transportation	0	0	19361	668	668
Total farm use	27847	1078	27680	955	2033
Non-farm use	0	0	0	0	0
Total	27847	1078	27680	955	2033

LIQUID FUEL USE BY OPERATION, 1983

FARM NO. 18

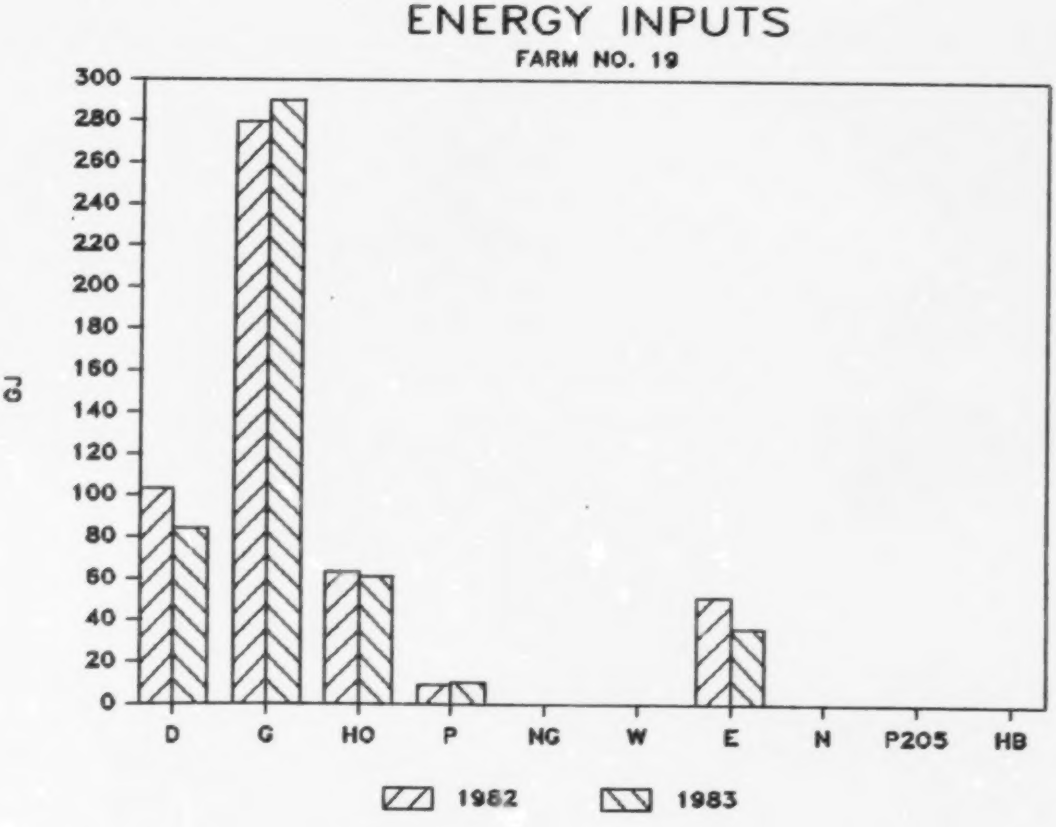


ENERGY INPUTS FARM NO. 19

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	2665	2178	103	84
Gasoline	G	L	8104	8408	280	290
Heating Oil	HO	L	1635	1579	63	61
Propane	P	L	358	403	9	10
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	14210	10055	51	36
Nitrogen	N	kg N	0	0	0	0
Phosphorus	P205	kg P205	0	0	0	0
Herbicides	HB	kg AI	NR	0	NR	0

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

FARM #19
Name: Ahner
Location: Maple Creek
Farm Type: Hay and Silage, Beef
Cultivated Area (ha): 121
Soil Zone: Brown

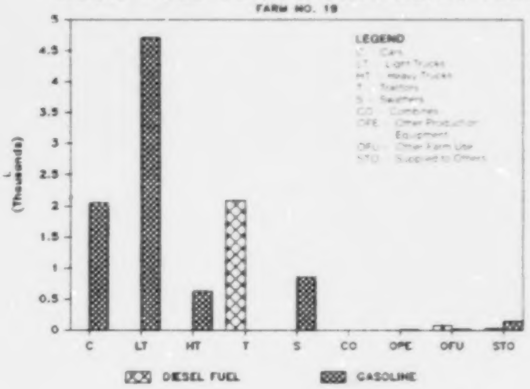


LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 19

EQUIPMENT	Total Fuel Use L	L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Non-energy use	72					
Supplied to others	26					
Tractor, Cocksh 1755, 1968	451	6.2	1.4			
Tractor, Cocksh 1850, 1964	1629					
Total	2178					
Gasoline						
Auger	13					
Car, Toyota, 1976	2040			10.4	9.6	27
Lawnmower	1					
Non-energy use	5					
Rototiller	10					
Supplied to others	146					
Swather, Vers 400, 1969	857					
Truck, 1/2 ton, F150, 1980	2997			16.1	6.2	18
Truck, 2 ton, Chev, 1977	626			44.6	2.2	6
Truck, Toyota, 1976	1713			26.2	3.8	11
Total	8408					

LIQUID FUEL USE BY EQUIPMENT, 1983

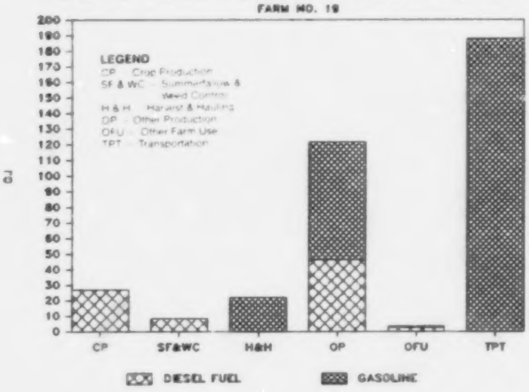


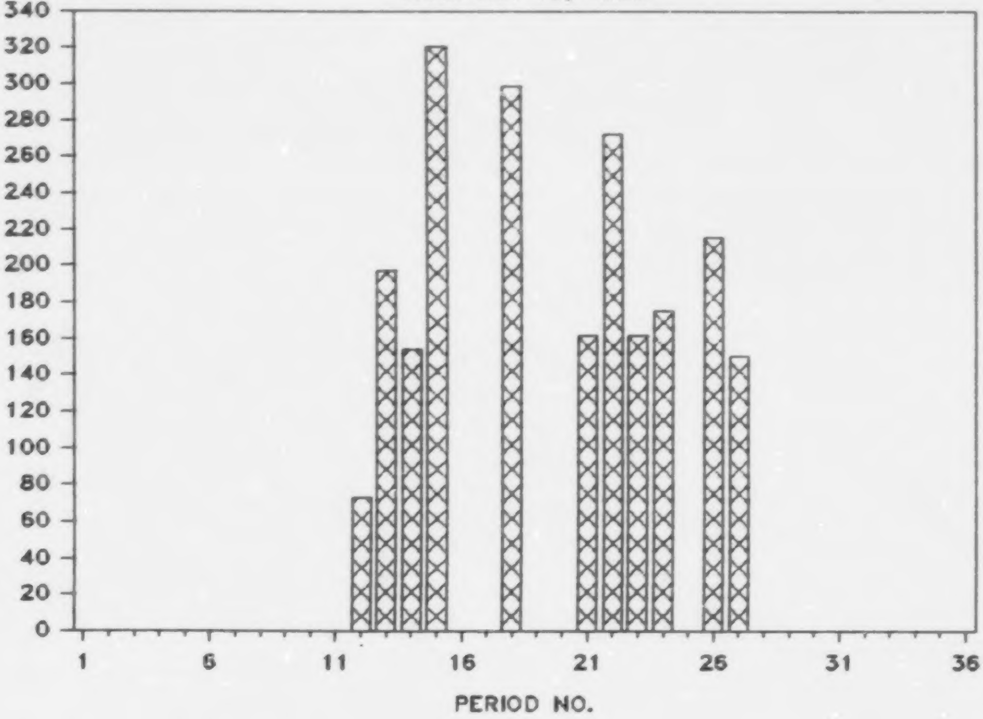
LIQUID FUEL USE BY OPERATION, 1983

Farm No. 19

OPERATION	Diesel Fuel L	GJ	L	Gasoline GJ	Total GJ
Crop production	692	27	0	0	27
Summerfallow & weed control	214	8	0	0	8
Harvest & hauling	0	0	635	22	22
Other production	1200	46	2177	75	122
Total production	2106	82	2812	97	179
Other farm use	72	3	16	1	3
Transportation	0	0	5434	187	187
Total farm use	2178	84	8262	285	369
Non-farm use	0	0	146	5	5
Total	2178	84	8408	290	374

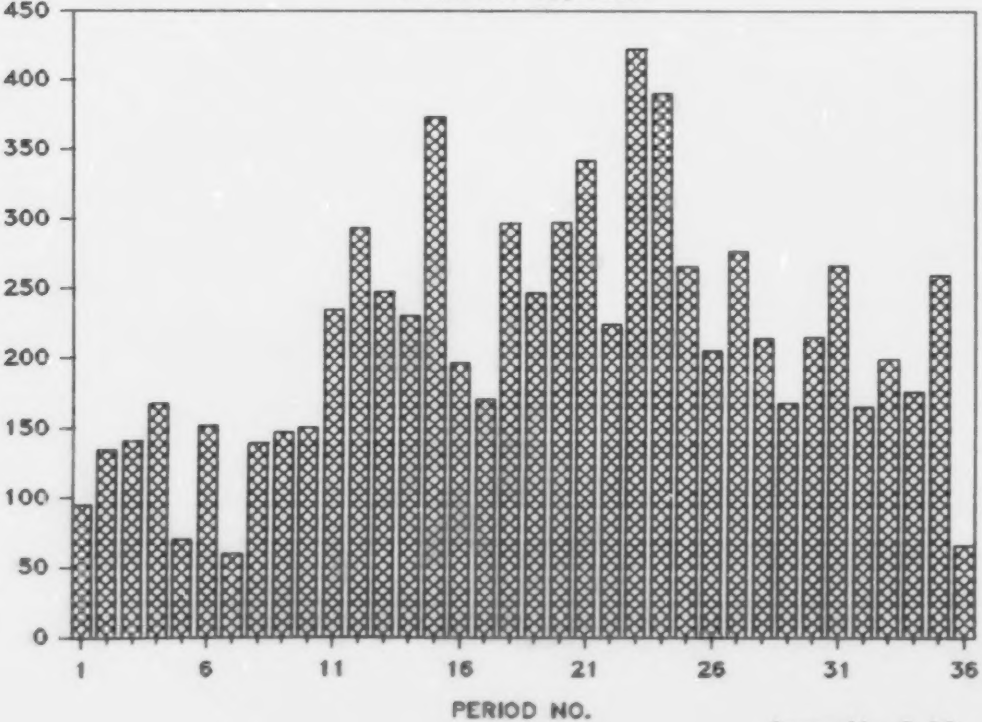
LIQUID FUEL USE BY OPERATION, 1983





USE OF DIESEL FUEL BY 10-DAY PERIOD

FARM NO. 19, 1983



USE OF GASOLINE BY 10-DAY PERIOD

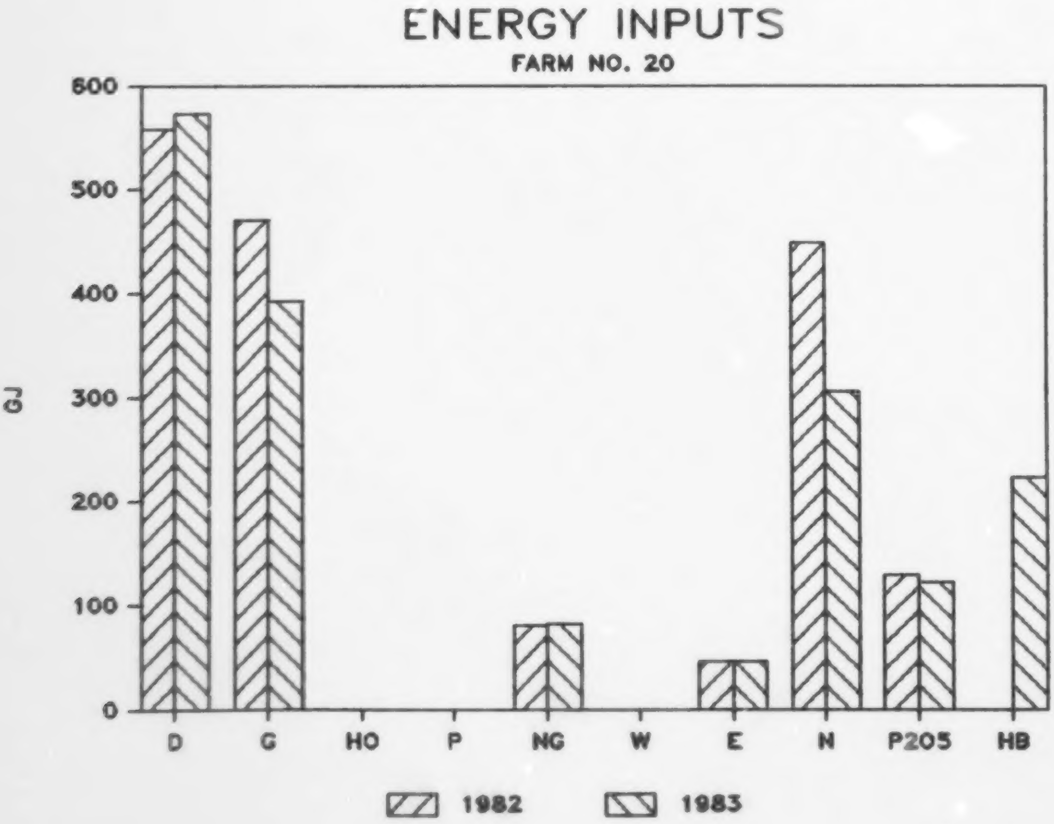
FARM NO. 19, 1983

ENERGY INPUTS FARM NO. 20

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	14432	14806	559	573
Gasoline	G	L	13625	11369	470	392
Heating Oil	HO	L	0	0	0	0
Propane	P	L	0	0	0	0
Natural Gas	NG	m^3	2170	2195	81	82
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	12802	12772	46	46
Nitrogen	N	kg N	6509	3876	449	306
Phosphorus	P205	kg P205	11781	11104	130	122
Herbicides	HB	kg AI	NR	853	NR	222

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

FARM #20
Name: Mickleborough
Location: Eston
Farm Type: Grain
Cultivated Area (ha): 968
Soil Zone: Brown



FARM NO. 20 - CROP PRODUCTION PRACTICES - 1983

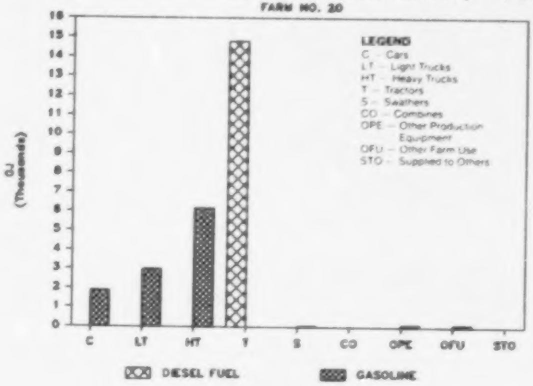
CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring Wheat	960		Discer	1X	✓		11-51-0	40	Avadex		40	
			Rodweed	1X	✓				Buctril M on 240 acres			
			Harrow pack	1X	✓				Glean on 90 acres			
			Spray	1X	✓				Hoegrass on 80 acres			
			Swath	1X	✓	✓			Matavex			
			Combine	1X	✓							
			Trucking			✓						
Barley	160		Discer	1X			11-51-0	40	Avadex		49.5	
			Rodweed	2X					Buctril M			
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley		80	Discer	1X			34-0-0	120	Buctril M		40	
			Harrow pack	1X			11-51-0	40				
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Fallow	1190		Cult (HD)	2X								
			Rodweed	2X								

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 20

EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Tractor, IHC 1066, 1976	6953	17.5	3.9			
Tractor, IHC 660, 1958	1050					
Tractor, JD 4010, 1962	2234					
Tractor MF 1130, 1969	4561	13.2	2.9			
Total	14806					
Gasoline						
Auger	137					
Car, Chrysler, 1972	1882			14.0	7.1	20
Garden tractor	20					
Non-energy use	96					
Supplied to others	21					
Swather, MF 655, 1970	58					
Truck, 1 ton, GMC, 1949	651			35.0	2.9	8
Truck, 1/2 ton, Dodge, 1964	937			20.7	4.8	14
Truck, 1/2 ton, Dodge, 1977	2043			19.5	5.1	14
Truck, 1/2 ton, GMC, 1976	1532			28.0	3.6	10
Truck, 2 ton, Chev, 1960	561			47.0	2.1	6
Truck, 3 ton, Chev, 1981	3431			47.0	2.1	6
Total	11369					

LIQUID FUEL USE BY EQUIPMENT, 1983

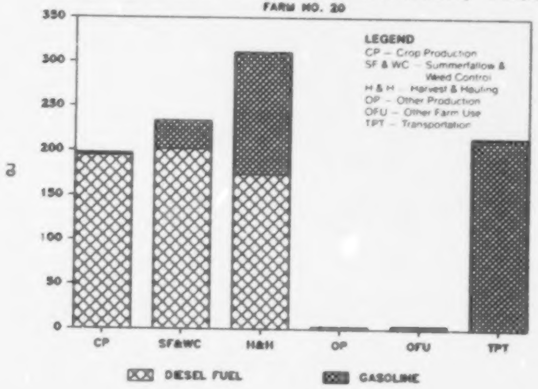


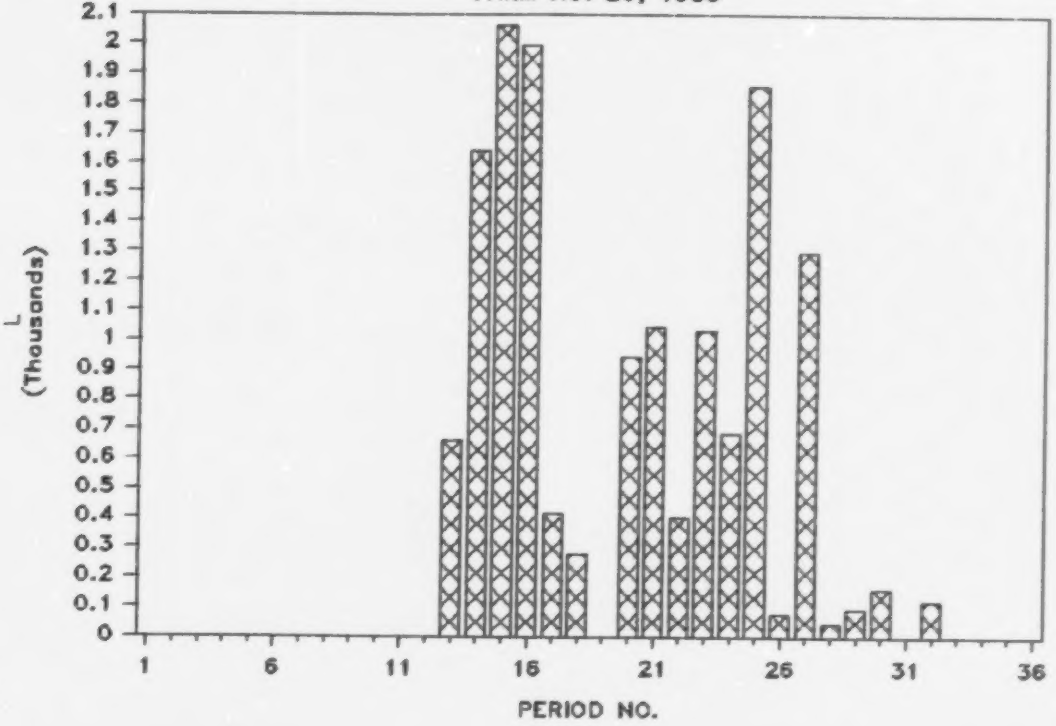
LIQUID FUEL USE BY OPERATION, 1983

Farm No. 20

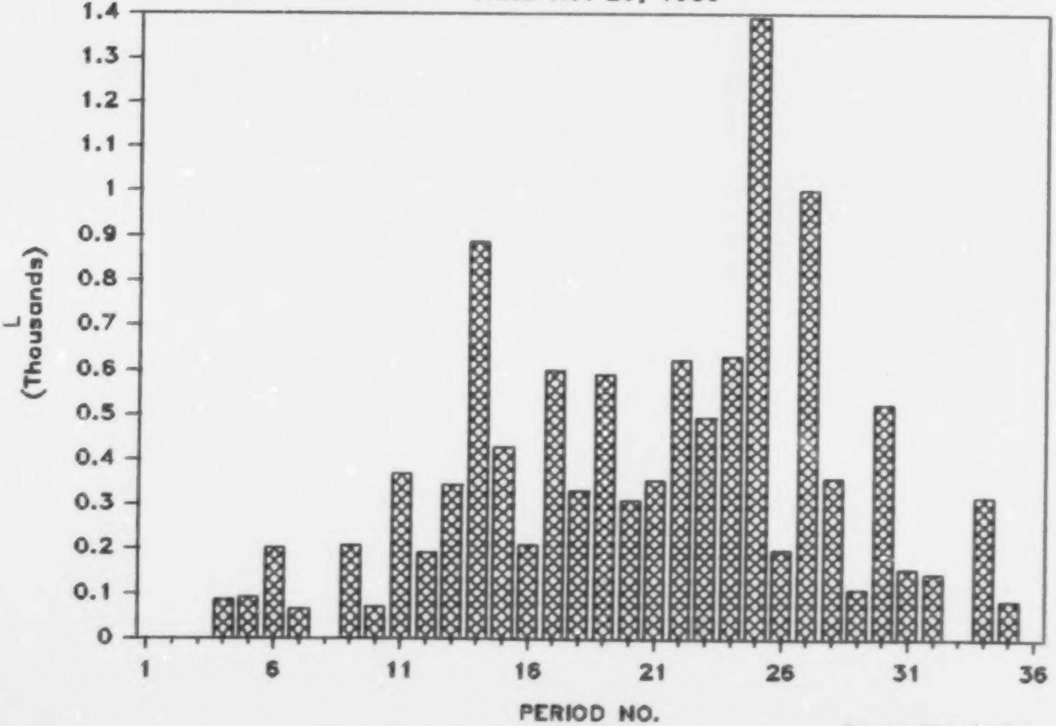
OPERATION	Diesel Fuel L	GJ	Gasoline L	GJ	Total GJ
Crop production	5024	194	82	3	197
Summerfallow & weed control	5220	202	918	32	234
Harvest & hauling	4484	174	3981	137	311
Other production	78	3	0	0	3
Total production	14806	573	4981	172	745
Other farm use	0	0	116	4	4
Transportation	0	0	6251	216	216
Total farm use	14806	573	11348	392	964
Non-farm use	0	0	21	1	1
Total	14806	573	11369	392	965

LIQUID FUEL USE BY OPERATION, 1983





USE OF DIESEL FUEL BY 10—DAY PERIOD
FARM NO. 20, 1983



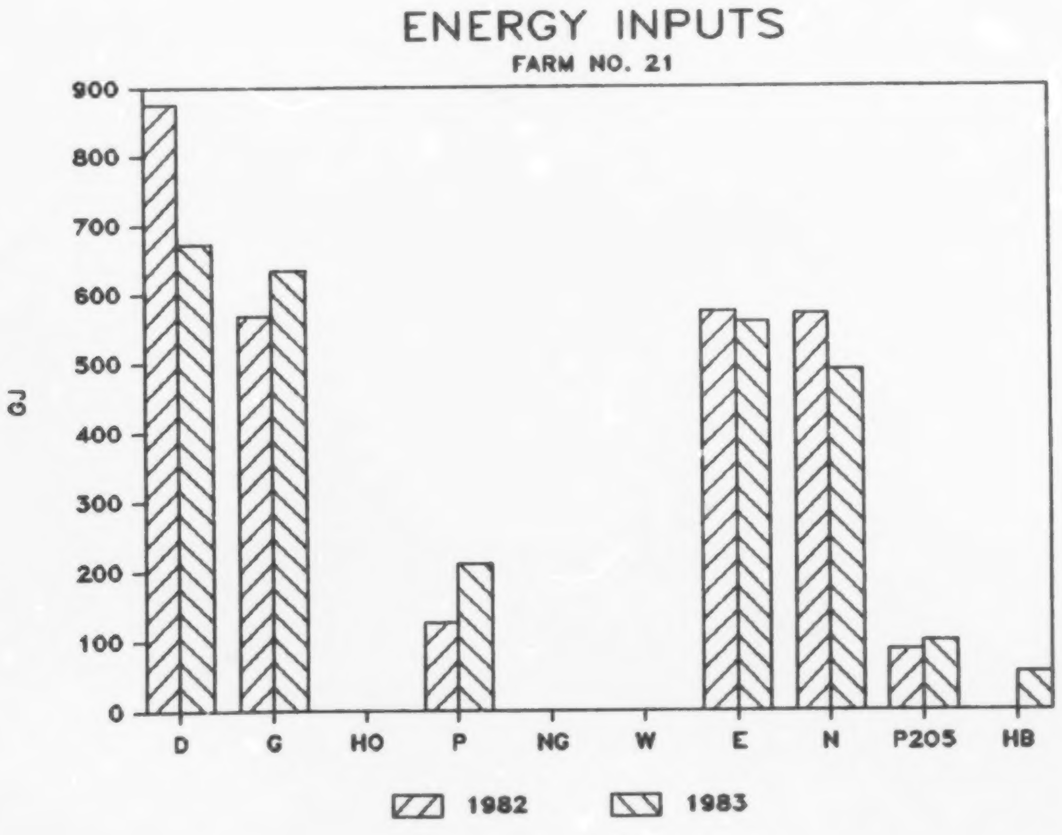
USE OF GASOLINE BY 10—DAY PERIOD
FARM NO. 20, 1983

FARM #21
Name: Burtney
Location: Cudworth
Farm Type: Grain and Silage, Dairy
Cultivated Area (ha): 603
Soil Zone: Black

ENERGY INPUTS FARM NO. 21

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	22615	17391	875	673
Gasoline	G	L	16450	18432	568	636
Heating Oil	HO	L	0	0	0	0
Propane	P	L	4948	8258	127	211
Natural Gas	NG	m^3	0	0	0	0
Wood	W	kg	0	0	0	0
Electricity	E	kW.h	159310	154728	574	557
Nitrogen	N	kg N	9040	7079	570	488
Phosphorus	P205	kg P205	7838	8915	86	98
Herbicides	HB	kg AI	NR	217	NR	54

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded



FARM NO. 21 - CROP PRODUCTION PRACTICES - 1983

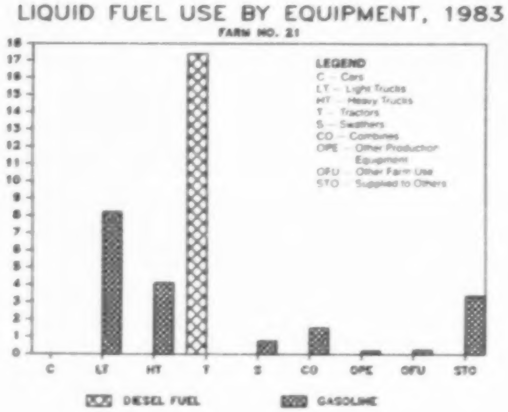
CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL		FERTILIZER TYPE	RATE (lb/ac)	HERBICIDES TYPE	RATE (oz/ac)	YIELD (bu/ac)	REMARKS
					D	G						
Spring wheat	521		Cultivator & Rod	1X	✓		11-51-0	50	2,4-D on	521 acres	37.5	
			Press Drill	1X	✓				Hoegrass	on 70 acres		
			Harrow	1X	✓				Stampede	on 120 acres		
			Spray	1.13X	✓							
			Swath	1X	✓							
			Combine	1X	✓							
			Trucking									
Spring wheat		50	Cultivator H.D.	2X			11-51-0	50	2,4-D		30.0	
			Anh. Appl.	1X			82-0-0	56				
			Harrow	1X								
			Press Drill	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Spring wheat		68	Cultivator	1X			27-26-0	60	2,4-D		30.0	
			Press Drill	1X								
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley			Cultivator	1X			27-26-0	75	2,4-D		38	
			Harrow	1X								
			Cult	1X								
			Press Drill	1X								
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley		58	Cult	1X			11-48-0	30	2,4-D		38	
			Harrow	1X								
			Cult	1X								
			Press Drill	1X								
			Harrow	1X								
			Spray	1X								
			Swath	1X								
			Combine	1X								
			Trucking									
Barley		80	Anh. Apl.	1X			82-0-0	50	2,4-D			Silaged 200t Try matter total
			Manure Sp.	1X								
			Cult	1X								
			Press Drill	1X								
			Harrow	1X								
			Spray	1X								
Oats	10		Cult	1X			82-0-0	50 lbs on 38 acres				silaged
			Press drill	1X								
			Harrow	1X								
Oats		48	Anh. Appl.	1X			82-0-0	50 lbs on 42 acres				silaged
			manuring	1X								
			Cult	1X								
			Press drill	1X								120(T) total oat silage
			Harrow	1X								
			Spray	1X								
Fallow	440		Cult and Harrow	4X								
			Anh. Appl.	0.20			82-0-0	50 lbs on 90 acres				
			Manure	0.14			Manure on 60 acres					

N.B. Straw baling not included.

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 21

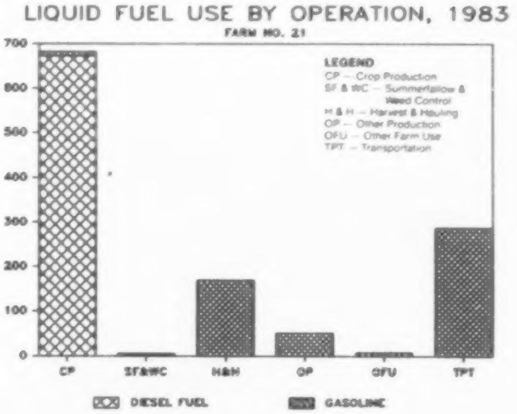
EQUIPMENT	Total Fuel Use L	L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Tractor, Case 2090, 19..	477	1.4	0.3			
Tractor, Case 2390, 1981	12186	23.8	5.2			
Tractor, JD 4020, 1967	4728	7.7	1.7			
Total	17391					
Gasoline						
Auger	82					
Combine, MF 510, 1975	1504					
Lawnmower	30					
Loader (rented)	84					
Non-energy use	40					
Power generator	8					
Pump	49					
Rototiller	17					
Snowmobile	157					
Supplied to others	3382					
Swather, White 504, 1980	750					
Truck (rented)	431					
Truck, 4x4, Chev, 1980	3810			23.0	4.3	12
Truck, 1/2 ton, F150, 1978	4399			20.2	5.0	14
Truck, 3 ton, Chev 60, 1980	123			54.4	1.8	5
Truck, 3 ton, IHC 1600, 1973	3566			51.6	1.9	5
Total	18432					



LIQUID FUEL USE BY OPERATION, 1983

Farm No. 21

OPERATION	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Crop production	17391	673	271	9	682
Summerfallow & weed control	0	0	172	6	6
Harvest & hauling	0	0	4898	169	169
Other production	0	0	1475	51	51
Total production	17391	673	6816	235	908
Other farm use	0	0	252	9	9
Transportation	0	0	8307	287	287
Total farm use	17391	673	15375	530	1203
Non-farm use	0	0	3057	105	105
Total	17391	673	18432	636	1309

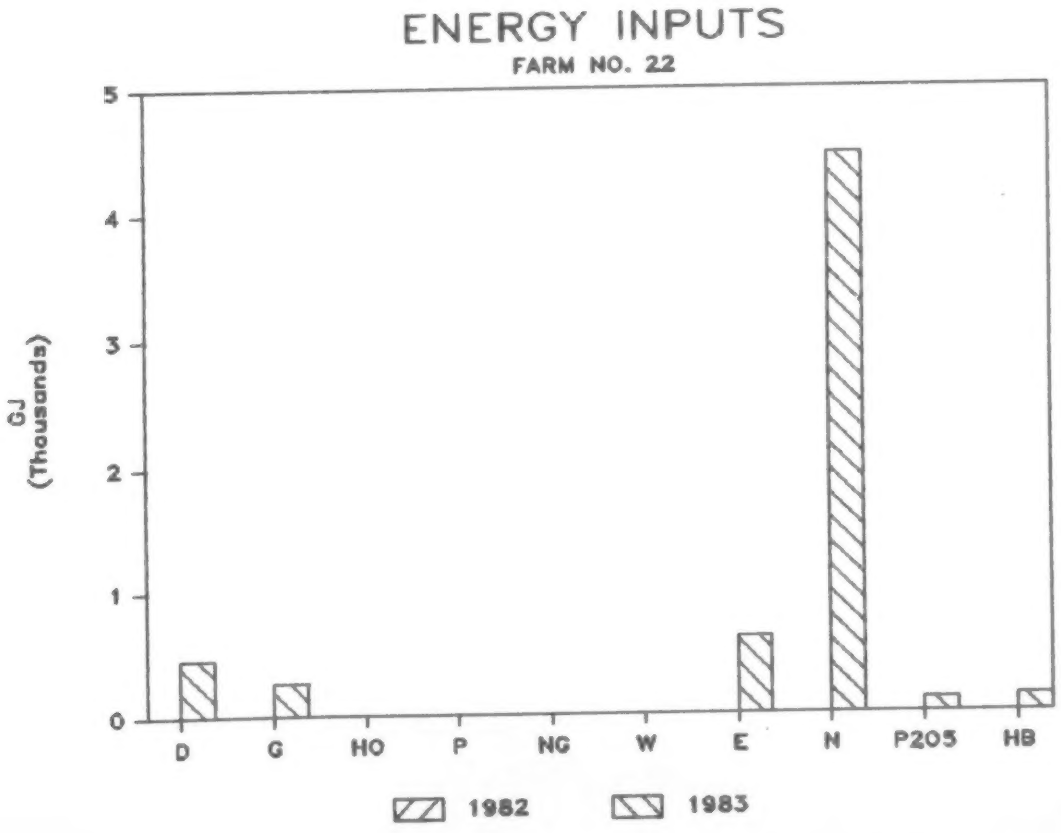


ENERGY INPUTS FARM NO. 22

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	NR	11597	NR	449
Gasoline	G	L	NR	7439	NR	257
Heating Oil	HO	L	NR	0	NR	0
Propane	P	L	NR	NR	NR	0
Natural Gas	NG	m^3	NR	0	NR	0
Wood	W	kg	NR	0	NR	0
Electricity	E	kW.h	NR	171120	NR	616
Nitrogen	N	kg N	NR	61217	NR	4469
Phosphorus	P205	kg P205	NR	9979	NR	110
Herbicides	HB	kg AI	NR	388	NR	138

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

FARM #22
Name: McBain
Location: Kindersley
Farm Type: Grain
Cultivated Area (ha): 518
Soil Zone: Brown



FARM NO. 22 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Winter wheat		900	Haybuster	1X	✓		11-55-0	30	Glean		29	
			Spray	1.24X	✓		34-0-0	300	Hoegrass	on 220 acres		very dry
			Spread fertilizer	1X	✓							
			Combine	1X	✓							
			Trucking			✓						
			Drying									
Winter wheat			Haybuster	1X	✓		11-55-0	30	Glean		29	very dry
			Spray	1X	✓		34-0-0	300				
			Spread fertilizer	1X	✓							
			Combine	1X	✓							
			Trucking			✓						
			Drying									
Winter wheat			Haybuster	1X	✓		11-55-0	30			29	
			Spread fertilizer	1X	✓		34-0-0	300				very dry
			Combine	1X	✓							
			Trucking			✓						
			Drying									
Spring wheat		160	Spray	1X	✓		11-51-0	40	Roundup	1/2 RR	40	
			Haybuster	1X	✓		34-0-0	300	Glean			
			Spray	1X	✓				Hoegrass			
			Spray	1X	✓							
			Spread fertilizer	1X	✓							
			Combine	1X	✓							
			Trucking			✓						
			Drying									

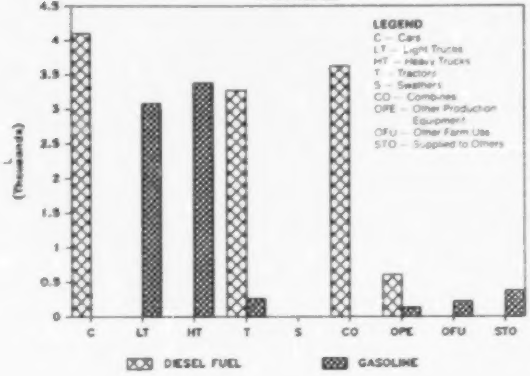
LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 22

	Total Fuel Use	-------Fuel Use Rate---------				
EQUIPMENT	L	L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Car, Chev Wagon, 1980	4100			14.6	6.8	19
Combine, 1R70, 1978	3627	16.5	3.6			
Sprayer marker	50					
Tractor, AC 305 (rented)	552					
Tractor, Case 930, 1964	2721	11.8	2.6			
Tractor, IHC 584, 1981	382	4.9	1.1			
Tractor, IHC 766 (rented)	165	1.5	0.3			
Total	11597					
Gasoline						
Auger	104					
Boat	47					
Lawnmower	44					
Non-energy use	30					
Pump	22					
Supplied to others	370					
Tractor, IHC W6, 1955	258					
Truck, 2 ton, GMC, 1948	109					
Truck, 2 ton, GMC, 1953	278					
Truck, 2 ton, Ford, 1959	95					
Truck, 1/2 ton, GMC, 1970	2000			25.1	4.0	11
Truck, 1/2 ton, GMC, 1973	1082			24.5	4.1	12
Truck, 3 ton, Dodge, 1975	1500			48.7	2.1	6
Truck, 3 ton, IHC, 1968	1500			58.1	1.7	5
Total	7439					

LIQUID FUEL USE BY EQUIPMENT, 1983

FARM NO. 22



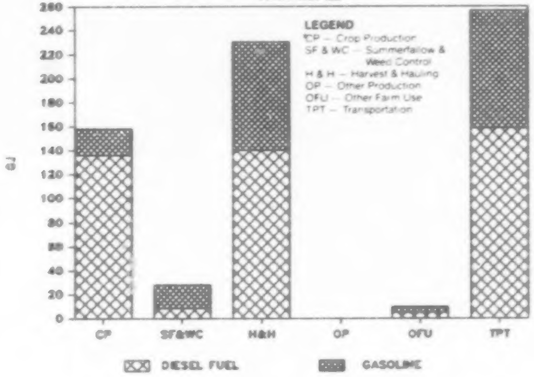
LIQUID FUEL USE BY OPERATION, 1983

Farm No. 22

	Diesel Fuel		Gasoline		Total
OPERATION	L	GJ	L	GJ	GJ
Crop production	3517	136	638	22	158
Summerfallow & weed control	224	9	565	19	28
Harvest & hauling	3627	140	2611	90	230
Other production	0	0	0	0	0
Total production	7368	285	3814	132	417
Other farm use	129	5	126	4	9
Transportation	4100	159	2837	98	257
Total farm use	11597	449	6777	234	683
Non-farm use	0	0	662	23	23
Total	11597	449	7439	257	705

LIQUID FUEL USE BY OPERATION, 1983

FARM NO. 22

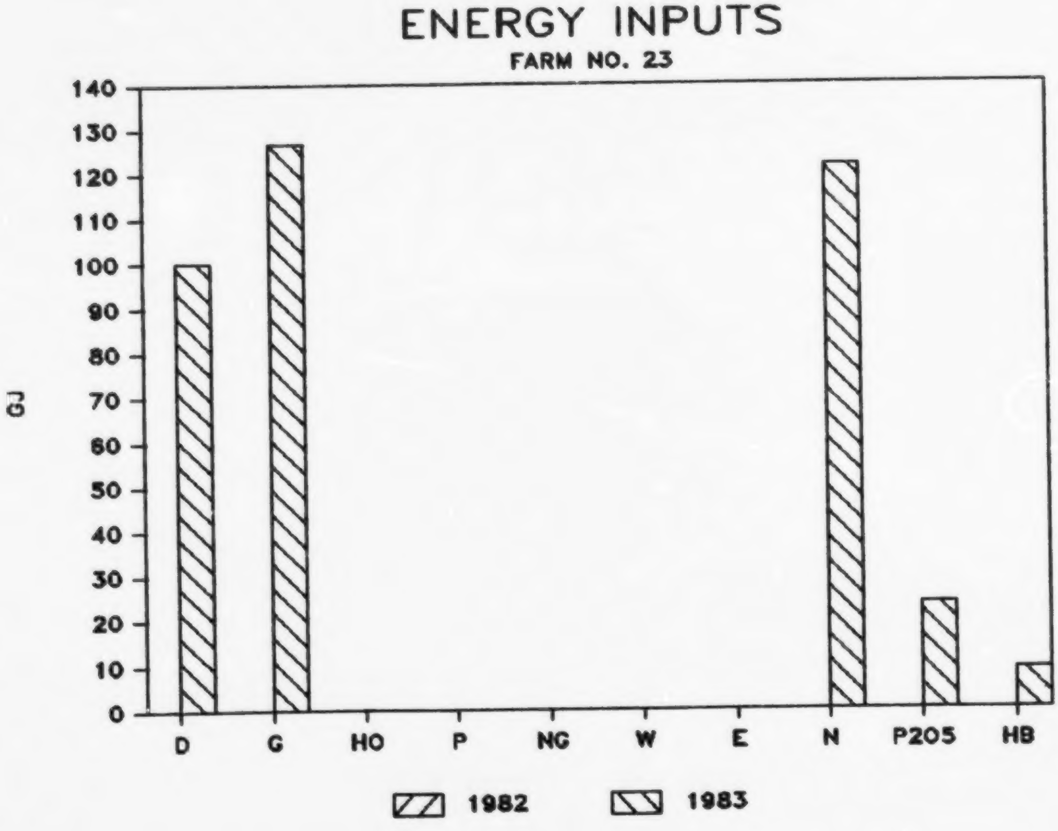


ENERGY INPUTS FARM NO. 23

			physical units		GJ	
			1982	1983	1982	1983
Diesel Fuel	D	L	NR	2591	NR	100
Gasoline	G	L	NR	3675	NR	127
Heating Oil	HO	L	NR	0	NR	0
Propane	P	L	NR	0	NR	0
Natural Gas	NG	m^3	NR	0	NR	0
Wood	W	kg	NR	0	NR	0
Electricity	E	kW.h	NR	0	NR	0
Nitrogen	N	kg N	NR	1643	NR	122
Phosphorus	P205	kg P205	NR	2145	NR	24
Herbicides	HB	kg AI	NR	35	NR	9

- diesel fuel and gasoline in 1982 and 1983 as metered
- electricity and natural gas from SPC records
- all other quantities as reported by farmer
- fall-applied fertilizer counted in following year
- NR = not recorded

FARM #23
Name: Howse
Location: Carragana
Farm Type: Grain
Cultivated Area (ha): 110
Soil Zone: Black (Dk. Grey)



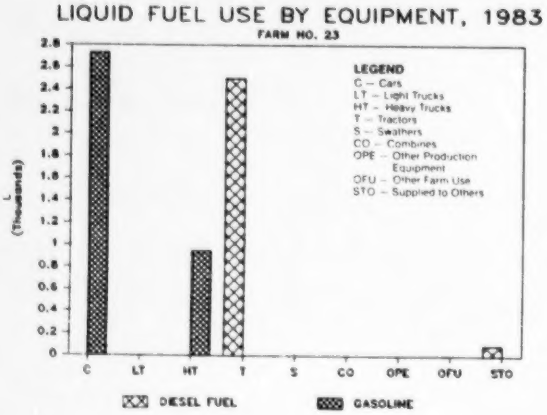
FARM NO. 23 - CROP PRODUCTION PRACTICES - 1983

CROPS	ON FALLOW (acres)	ON STUBBLE (acres)	FIELD OPERATIONS MACHINE	NO.	FUEL D	FUEL G	FERTILIZER TYPE	FERTILIZER RATE (lb/ac)	HERBICIDES TYPE	HERBICIDES RATE (oz/ac)	YIELD (bu/ac)	REMARKS
Spring Wheat		75	Tandem Disc	1X	✓		23-24-0	95	Hoegrass		28	Wheat midge infestation
			Cult (HD)	1X	✓				MCPA			
			Harrow	1X	✓							
			Press Drill	1X	✓							
			Harrow	1X	✓							
			Spray	1X	✓							
			Swath	1X		✓						
			Combine	1X	✓							
			Trucking			✓						
Barley		75	Tandem Disc	1X	✓		23-24-0	100			42	
			Tandem Disc	1X	✓							
			Cult (HD)	1X	✓							
			Press Drill	1X	✓							
			Spray	1X	✓							
			Swath	1X		✓						
			Combine	1X	✓							
			Trucking			✓						
Fallow		120	Tandem Disc	1X			11-51-0	20				
Pea and Oats			Cult (HD)	1X								
Ploughdown			Press Drill	1X								
			MOW	1X								
			Tandem Disc	2X								
			Cult (HD)	1X								
			Press Drill	.5X			11-51-0	50	Smut Fungicide			Winter wheat on 60 acres only
Hay			Swath	1X							7000 lbs	
Brome Alfalfa			Bale	1X								

LIQUID FUEL USE AND FUEL USE RATE BY EQUIPMENT, 1983

Farm No. 23

EQUIPMENT	Total Fuel Use L	Fuel Use Rate L/h	gph	L/100 km	km/L	mpg
Diesel Fuel						
Supplied to others	91					
Tractor, Deutz D190, 1979	2500	6.5	1.4			
Total	2591					
Gasoline						
Car, Ford Falcon, 1960	527			12.6	7.9	22
Car, Mercury Monarch, 1977	2203			11.4	8.8	25
Truck, 2.5 ton, GMC, 1969	945			32.6	3.1	9
Total	3675					



LIQUID FUEL USE BY OPERATION, 1983

Farm No. 23

OPERATION	Diesel Fuel L	Diesel Fuel GJ	Gasoline L	Gasoline GJ	Total GJ
Crop production	1715	66	0	0	66
Summerfallow & weed control	170	7	0	0	7
Harvest & hauling	489	19	945	33	52
Other production	12	0	0	0	0
Total production	2386	92	945	33	125
Other farm use	114	4	0	0	4
Transportation	0	0	2730	94	94
Total farm use	2500	97	3675	127	224
Non-farm use	91	4	0	0	4
Total	2591	100	3675	127	227